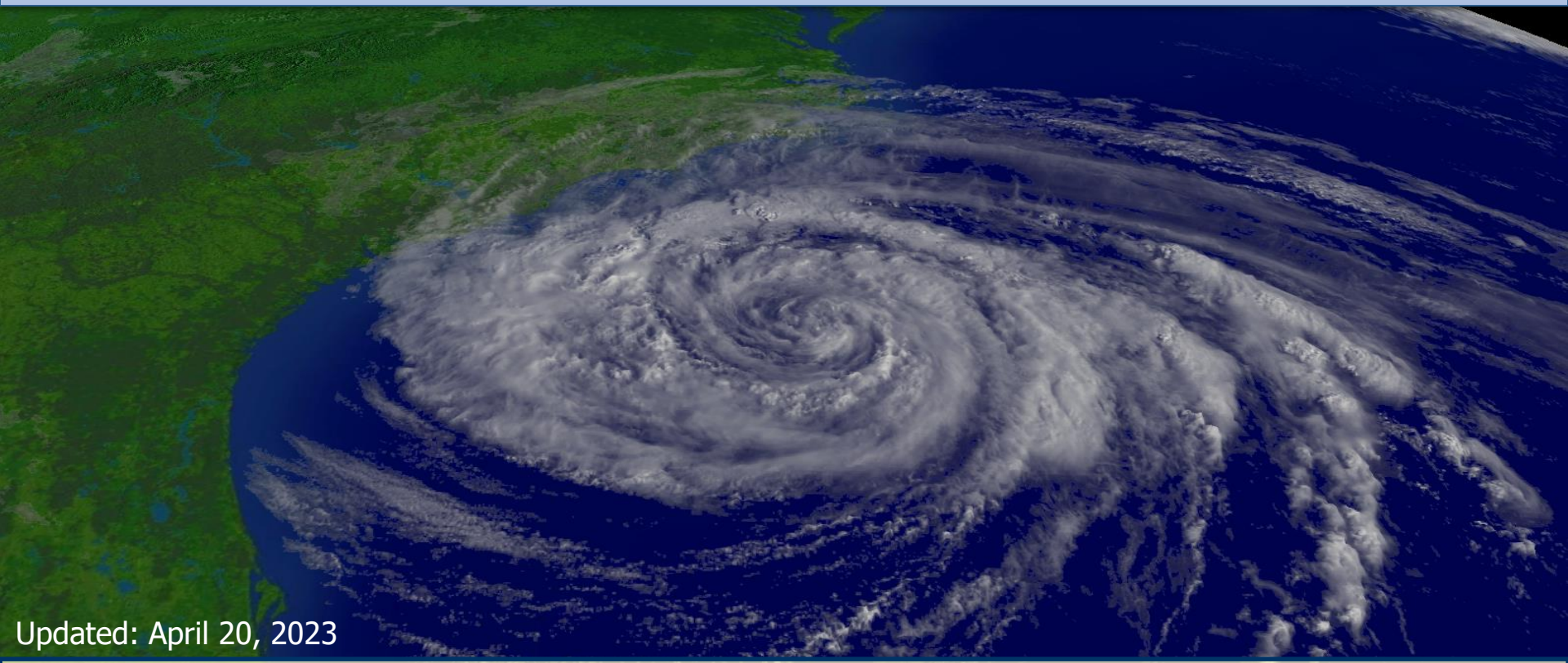
Hurricane Guide for

Southeast North Carolina & Northeast South Carolina

Plan, Act, Survive!

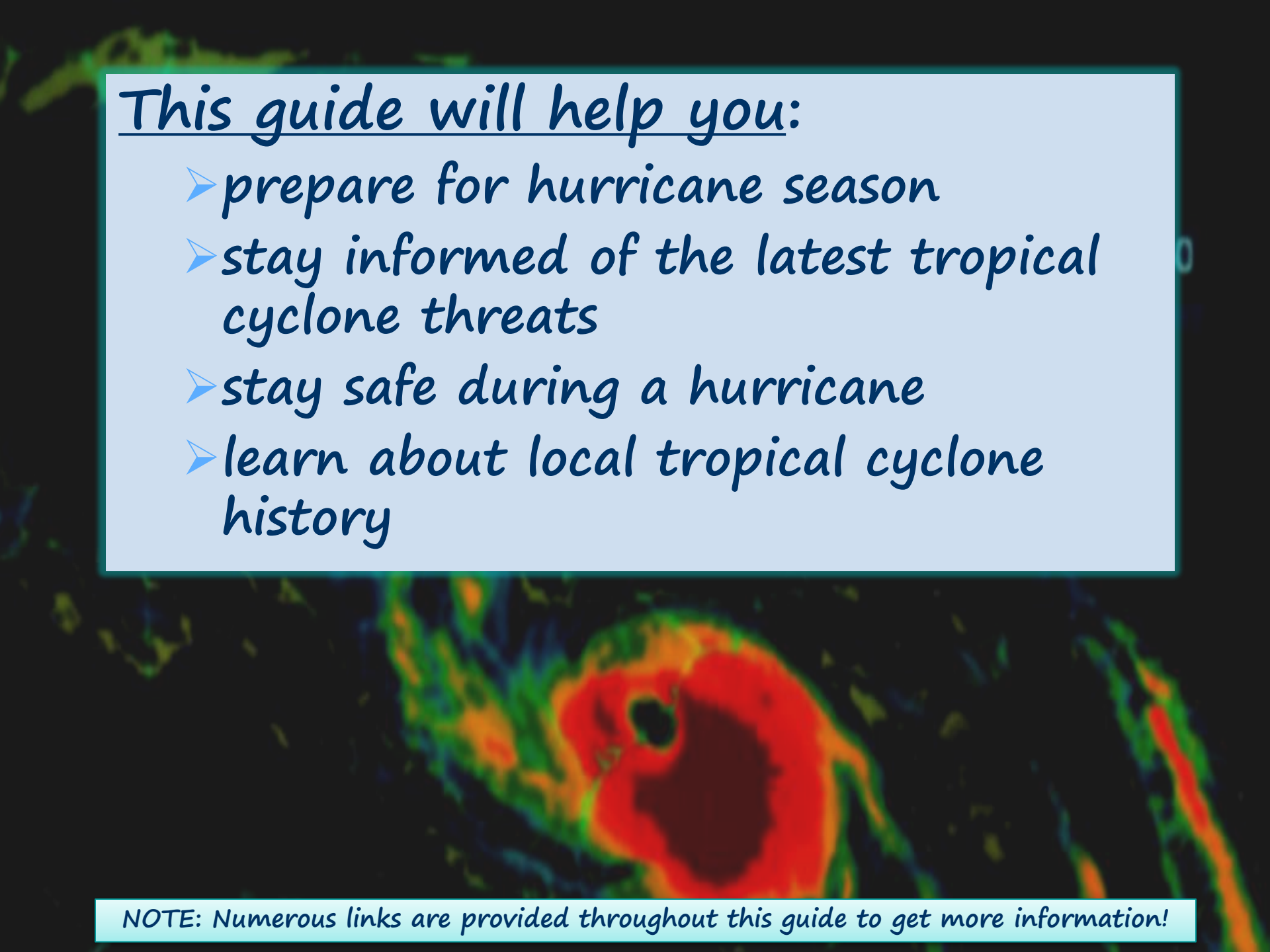


Updated: April 20, 2023

National Weather Service

Wilmington, NC

weather.gov/ilm



This guide will help you:

- prepare for hurricane season
- stay informed of the latest tropical cyclone threats
- stay safe during a hurricane
- learn about local tropical cyclone history

NOTE: Numerous links are provided throughout this guide to get more information!

Outline

- **Tropical Cyclone Hazards**
- Being Prepared and Staying Informed
- Tropical Cyclone Basics
- Tropical Cyclone Climatology
- Tropical Cyclone History for Southeast North Carolina and Northeast South Carolina

Main Tropical Cyclone Hazards

Storm Surge

Flooding Rains

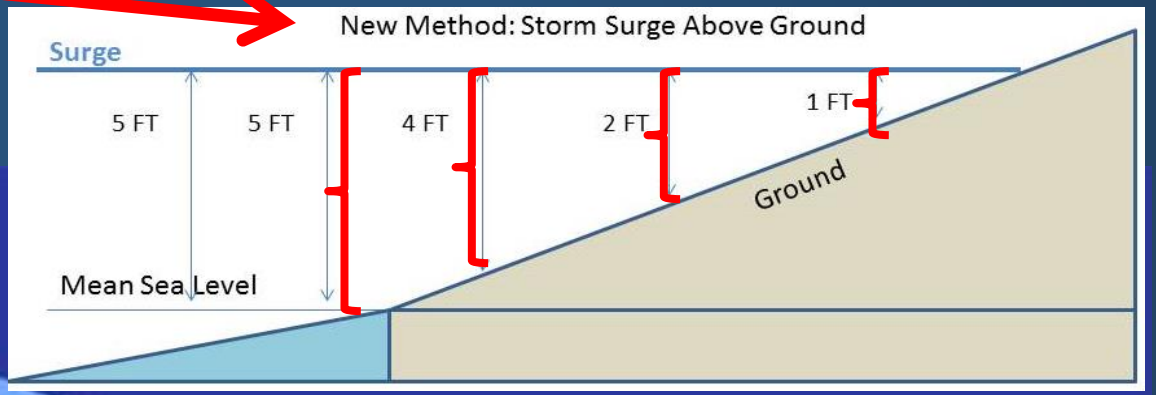
Rip Currents

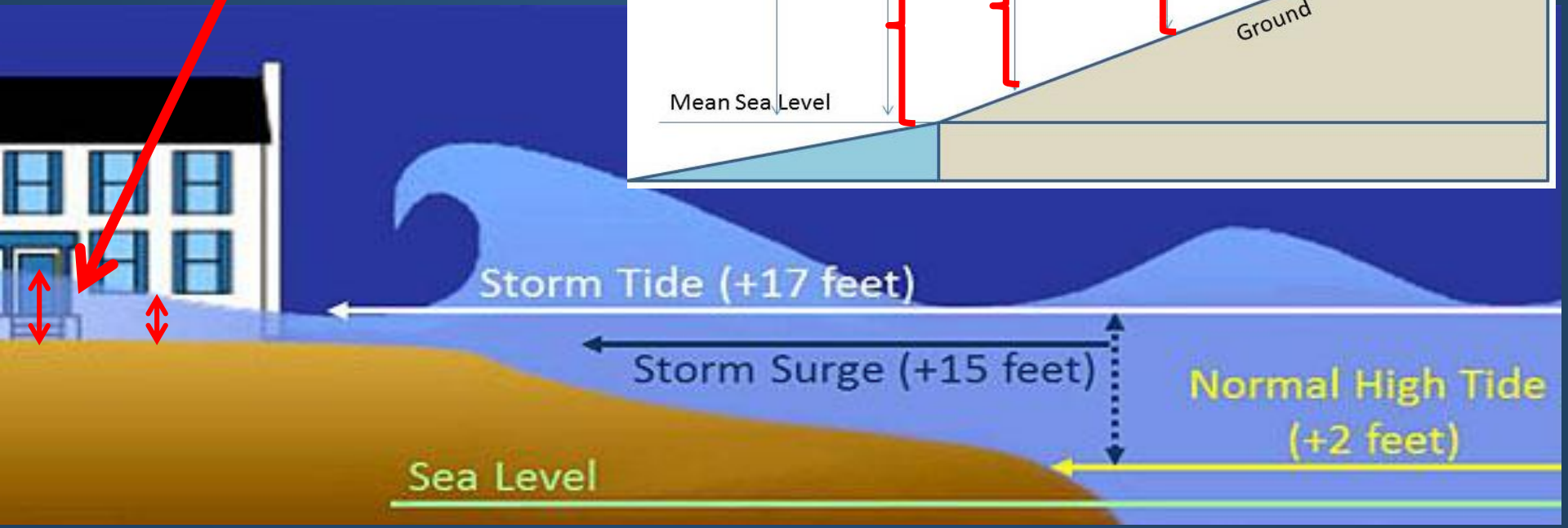
High Winds

Tornadoes/Waterspouts

Storm Surge Terminology

- **Storm surge**: abnormal rise of water generated by a storm
- **Storm tide**: storm surge + astronomical tide
- **Inundation**: depth of water above the ground

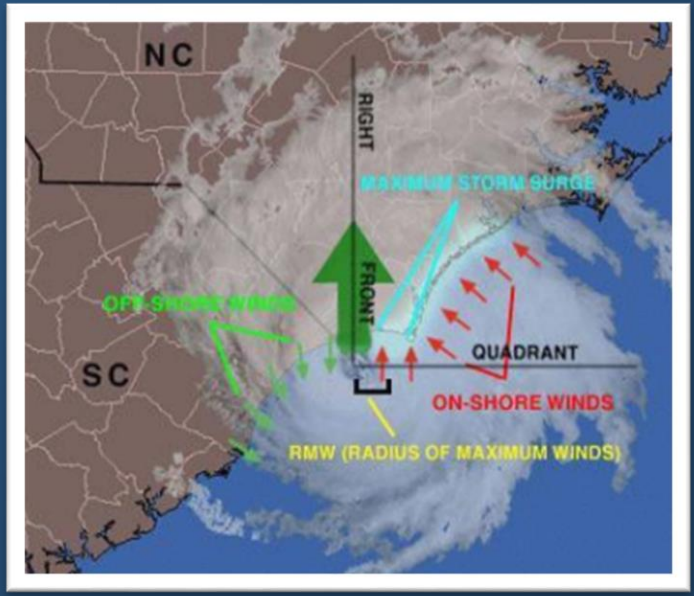




Storm Surge Facts

- Greatest threat to life and property along the coast!!
- Can occur rapidly and forcefully and travel many miles inland along low-lying/tidal areas
- Produced mainly by strong winds blowing over the ocean for an extended period
- Stronger, larger and faster storms generally produce more surge
- Amount of surge is <u>not</u> directly correlated with a storm's maximum winds!
- Greatest surge at the coast typically occur to the right of where the center of the storm comes ashore (blue area outlined in the image to the right)

Surf City, NC after Hurricane Florence (2018)



« Images courtesy of NWS

Storm Surge Facts

- There could be several more feet of storm tide if the highest storm surge occurs around the time of the high astronomical tide compared to low tide

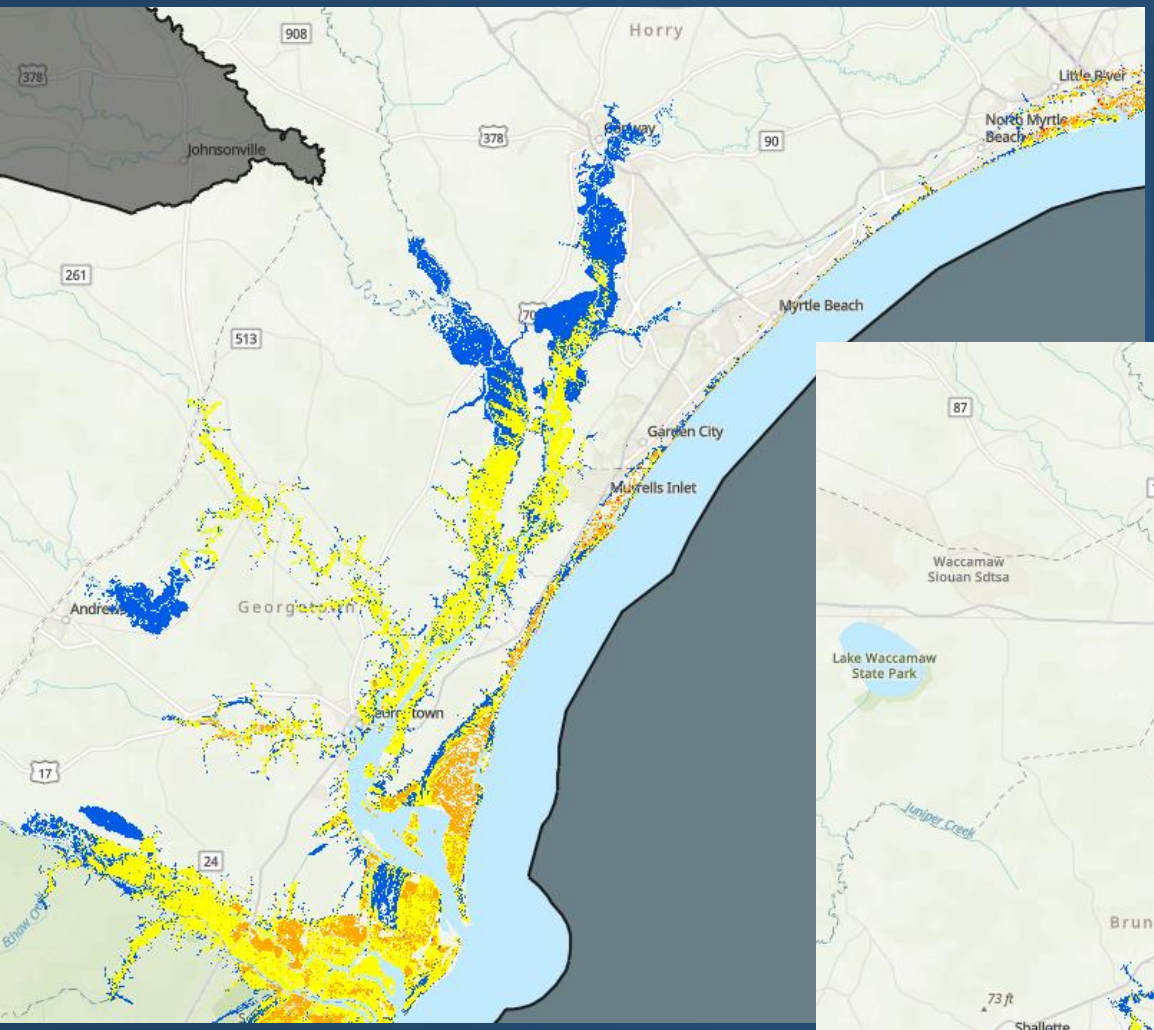
- Coastal areas of SC/NC are very surge-prone given the low elevation and gently sloping continental shelf offshore

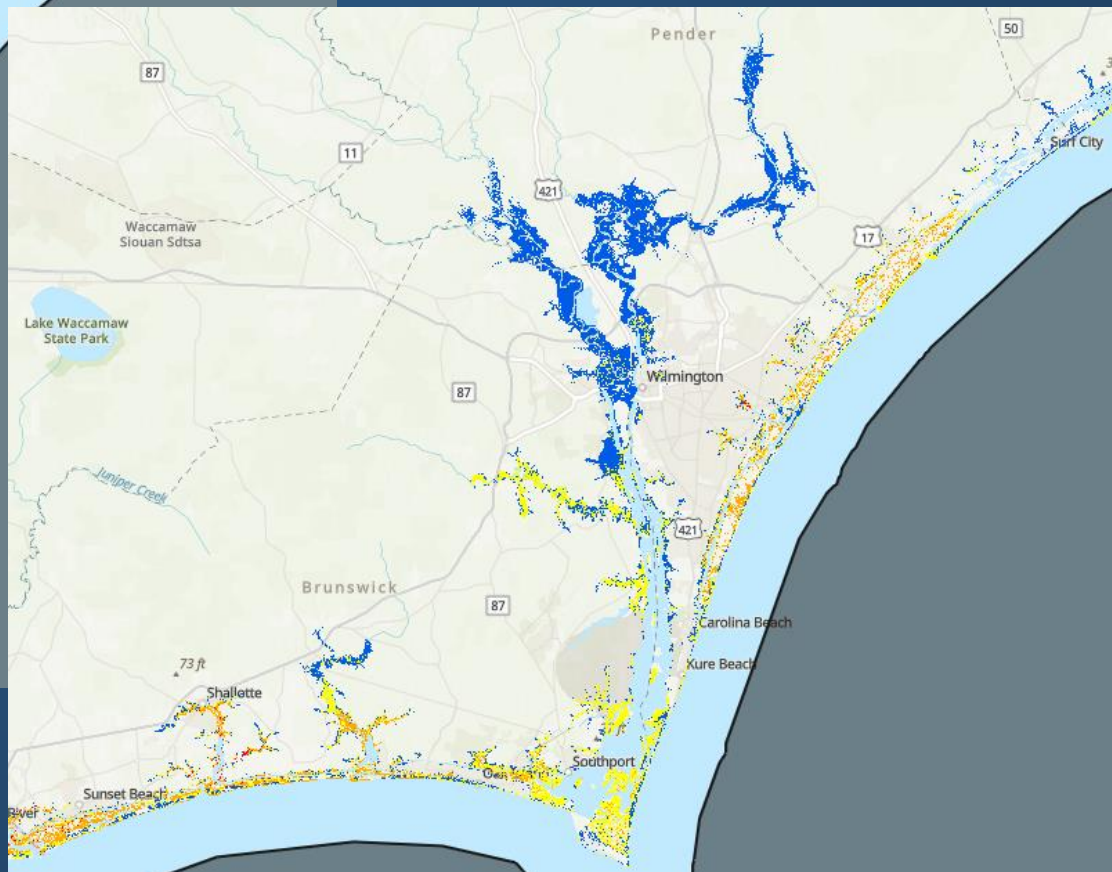
« *Image courtesy of NWS*

Pawley's Island, SC – Hurricane Matthew (2016)

Local Storm Surge Inundation Risk

Southeast NC & Northeast SC





- Note that you don't have to be at the beach to experience saltwater inundation!

- The greatest risk (deepest water) is denoted in warm colors (red/orange) and the lowest risk (shallowest water) is denoted by cool colors (blue)

Are You At Risk From Storm Surge?

- If you live in/near any of the highlighted areas on the maps on the previous slide then you are vulnerable to inundation from storm surge!
  - Check out NOAA's storm surge risk maps for more details

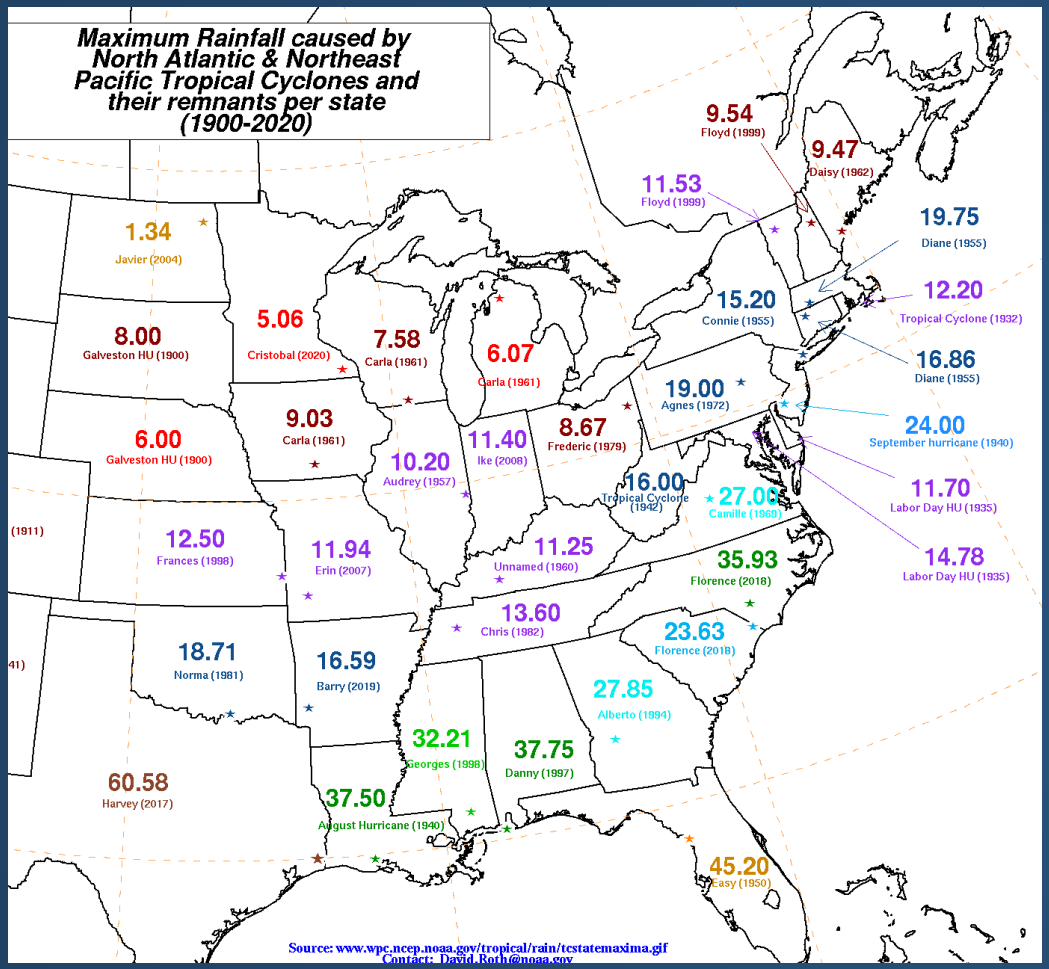
- Determine whether you are in an evacuation zone
- **Evacuate if advised to do so by local authorities!**
- Keep in mind that if you don't evacuate, your location may become an "island" that is cut off from emergency officials

Flooding Rainfall

- When you think "hurricane", "tropical storm" or even "tropical depression", "flooding"!
- Most deaths in recent tropical cyclones have been from inland fresh water flooding
- Weak storms can still produce a lot of rainfall
- Slow-moving storms can produce more rainfall
- Determine whether you live in a flood zone and evacuate if advised to do so by local officials
- Never drive through flooded roads since you don't know how deep the water is and the road may be washed out

*** It only takes ~1 foot of water to move most small vehicles!!

Flooding Rainfall



Flooding on NC Highway 210 at Moore's Creek from Hurricane Florence (2018)

« *Images courtesy of NWS/Weather Prediction Center (left) and NWS Wilmington (right)*

- The coastal areas of northeast SC and southeast NC, particularly urban areas like downtown Wilmington, are particularly vulnerable to flooding when storm tides are also high at the same time

High Wind Facts

- Damaging winds can occur hundreds of miles from the coast
  - In fact, Hurricane Hugo (1989) produced hurricane force wind gusts well inland in Charlotte, NC
- Generally the stronger the storm at landfall the longer it will take for the winds to diminish
- Coastal areas/higher buildings:
  - Sustained winds normally higher due to less surface friction
- Inland areas away from the immediate coast:
  - Sustained winds generally lower than at coast but gusts can be similar to sustained winds at coast

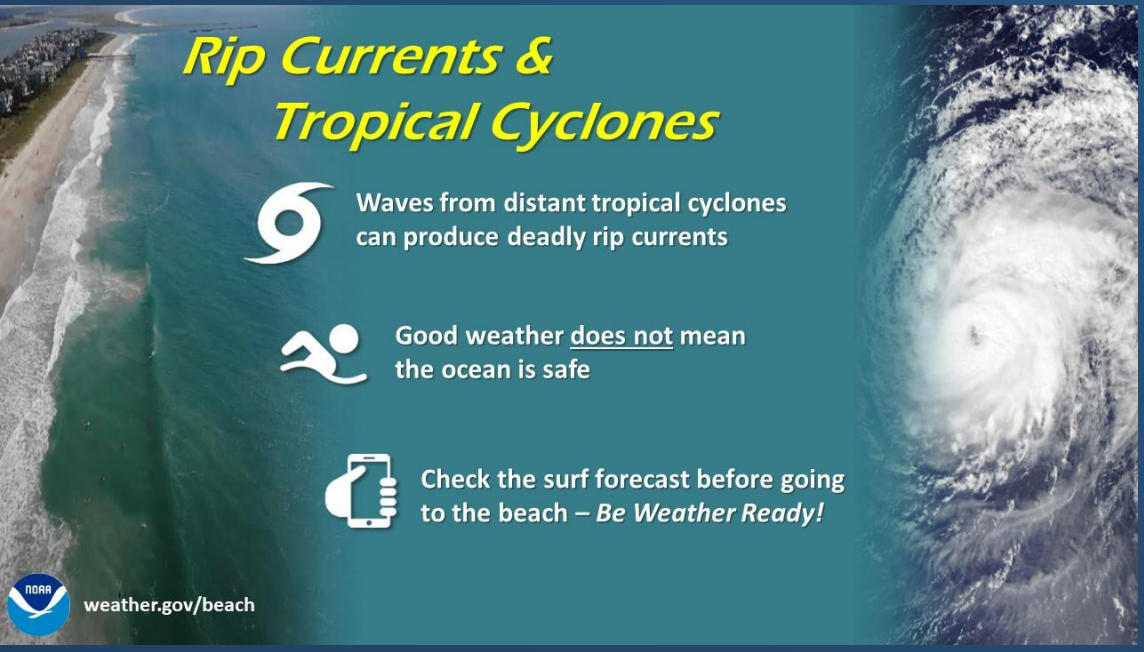
Hurricane Fran (1996)

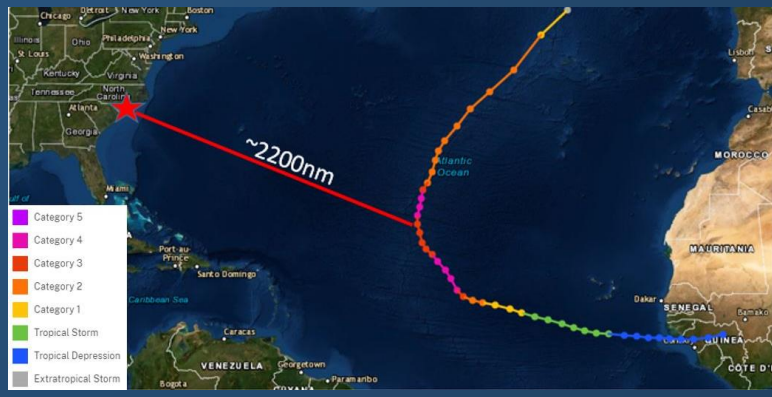
High Wind Safety

- Cover all windows and doors with plywood or shutters
  - Do NOT leave any windows/doors open to relieve pressure
  - Tape does NOT work!
- Reinforce garage doors as they are typically weak points
- Store all outdoor items that could become deadly missiles
- Evacuate to a more sturdy structure if you live in a mobile/manufactured home, especially if advised to do so by local authorities
- During a storm, go to your "safe place" which should be the most interior room on the lowest floor of your building that is not prone to flooding and protect your head with helmets or pillows

Rip Currents

- Can be life-threatening to anyone entering the surf, **even for storms that are far from the local coastal areas**!
- Be sure to follow our beach forecast for the latest rip current risk before you decide to enter the surf
  - weather.gov/beach/ilm





» Distant Hurricane Lorenzo in 2019 caused 4 fatalities in NC

Tornadoes/Waterspouts

- Even weaker tropical cyclones can still produce many tornadoes/waterspouts
- Typically short-lived (minutes) and weak (EF0-EF1: up to 110 mph) but can be longer/stronger
- Typically occur within the storm's outer rain bands and near the center (eye wall) and thus can impact preparedness activities well in advance of a storm
- During the storm, if the NWS issues a "Tornado Warning" or "Extreme Wind Warning" for your location, go to your "safe place" (i.e., most interior room on lowest floor not prone to flooding)

» *Image courtesy of NWS*

Hurricane Dorian (2019)

Outline

- Tropical Cyclone Hazards
- **Being Prepared and Staying Informed**
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Before the Storm…

- Determine whether you are vulnerable to flooding from storm surge
  - If you live in/near any of the shaded areas on the surge maps found earlier in this guide you are vulnerable to storm surge inundation!
  - Refer to your county emergency management office… SC / NC
- Learn if you live in a pre-designated evacuation zone… SC / NC
- If you are evacuating, find a hotel/shelter and learn evacuation routes
- Get a disaster supply kit that includes sufficient food and water
- Consider prepping your home by boarding up windows/doors with plywood and trimming trees and shrubbery
- Review your insurance policy (Note: flooding is not covered and must be purchased via the National Flood Insurance Program for which there is roughly a 30 day waiting period)
- Make plans for your pets since some shelters/hotels do not accept them

Remember…preparation is key!

If evacuating…leave early!!

NOTE: An average size car will flip in 115 mph winds!

Tropical Wind/Storm Surge Watch/Warning Definitions

Watches – conditions possible within ~48 hours of TS force winds

Tropical Storm	Tropical storm force winds (39-73 mph)
Hurricane	Hurricane force winds (74+ mph)
Storm Surge	Life-threatening inundation (3+ feet above ground)

Warnings – conditions expected within ~36 hours of TS force winds

Tropical Storm	Tropical storm force winds (39-73 mph)
Hurricane	Hurricane force winds (74+ mph)
Storm Surge	Life-threatening inundation (3+ feet above ground)

If a Watch is Issued For Your Area…

- Determine whether you are vulnerable to flooding from storm surge and/or heavy rainfall
- Learn if you live in a pre-designated evacuation zone and what the official evacuation routes are
- Evacuate if you are advised to do so by officials, and do so early!
- If evacuating, notify your friends/family and note that some shelters/hotels do not accept pets
- Review your disaster plan and check your supply kit
- Prepare your home by trimming weak/dead branches, covering windows/doors and bringing in unsecured outdoor items
- Inspect/secure mobile home tie downs
- Gas your vehicles and get cash since ATMs won't work w/o power
- Store drinking water in jugs, bottles and clean bathtubs
  - at least 1 gallon per person per day for 3 days is recommended

If a Warning is Issued For Your Area…

- **Rush protective actions to completion!!**
- Evacuate as soon as possible, especially if advised to do so by authorities!
  - Notify friends/family of where you are going
  - Take your disaster supply kit with you
  - Unplug appliances and turn off electricity/main water valve
- If not evacuating…
  - Be sure you are not vulnerable to flooding from storm surge or heavy rainfall
  - Ready your disaster supply kit
  - Turn your refrigerator/freezer to their coldest settings and keep closed as much as possible
  - Cover windows/doors and store unsecured outdoor items
  - Fill bathtubs and large containers with water for cleaning/flushing purposes in case clean tap water becomes unavailable
    - at least 1 gallon per person per day for 3 days is recommended
  - Inspect/secure mobile home tie downs
  - If power is lost, turn off major appliances to reduce power "surge" when electricity is restored

After the Storm…

- If you have evacuated, don't return home until notified by officials
- Watch for downed trees/power lines, glass, nails, and other debris as well as snakes, insects and other animals
- Don't drive through flooded roads
- Don't run power generators indoors
- Help your neighbors
- Be patient
- More recovery tips…. https://www.ready.gov/recovering-disaster

« Images courtesy of NWS

Staying Informed:

Real-time Storm Information

- Web:
  - NWS Wilmington, NC: weather.gov/ilm
  - National Hurricane Center: hurricanes.gov
- Social Media:
  - NWS Wilmington Facebook: facebook.com/NWSWilmingtonNC
  - NWS Wilmington Twitter: @NWSWilmingtonNC
- Mobile:
  - hurricanes.gov/mobile
- NOAA Weather Radio:
  - weather.gov/nwr/
- Local TV/Radio

NWS Tropical Products/Services

National Hurricane Center

- Forecasts the development, track, and strength of tropical cyclones

hurricanes.gov

NWS Wilmington, NC

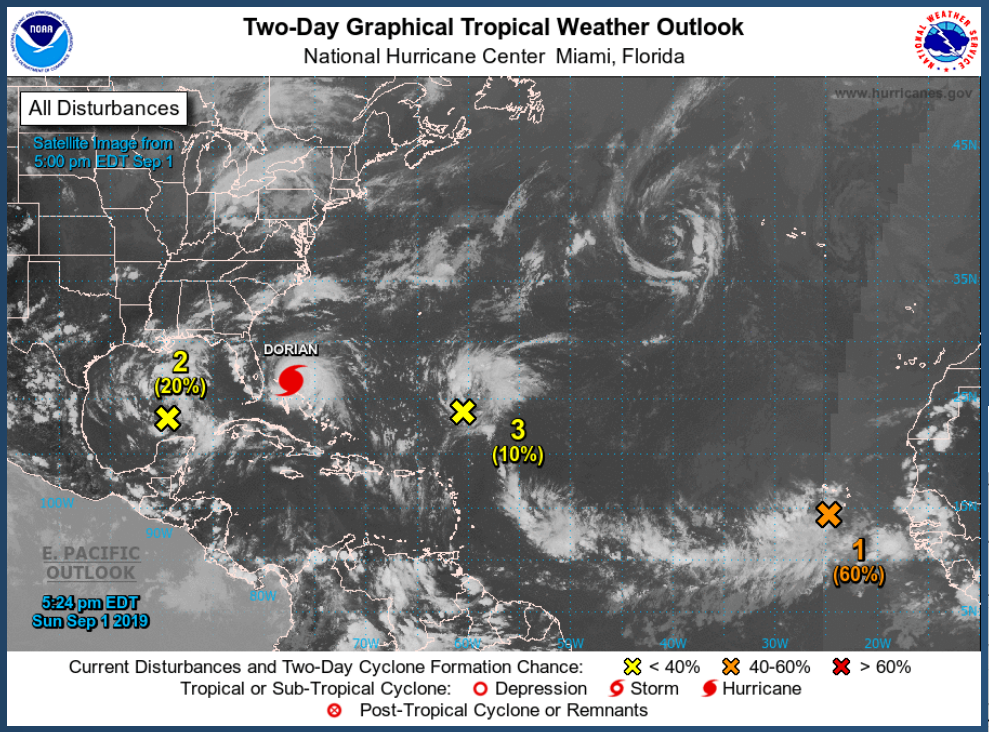
- Forecasts the potential impacts from tropical cyclones across southeast NC/northeast SC

weather.gov/ilm

NHC Tropical Weather Outlook

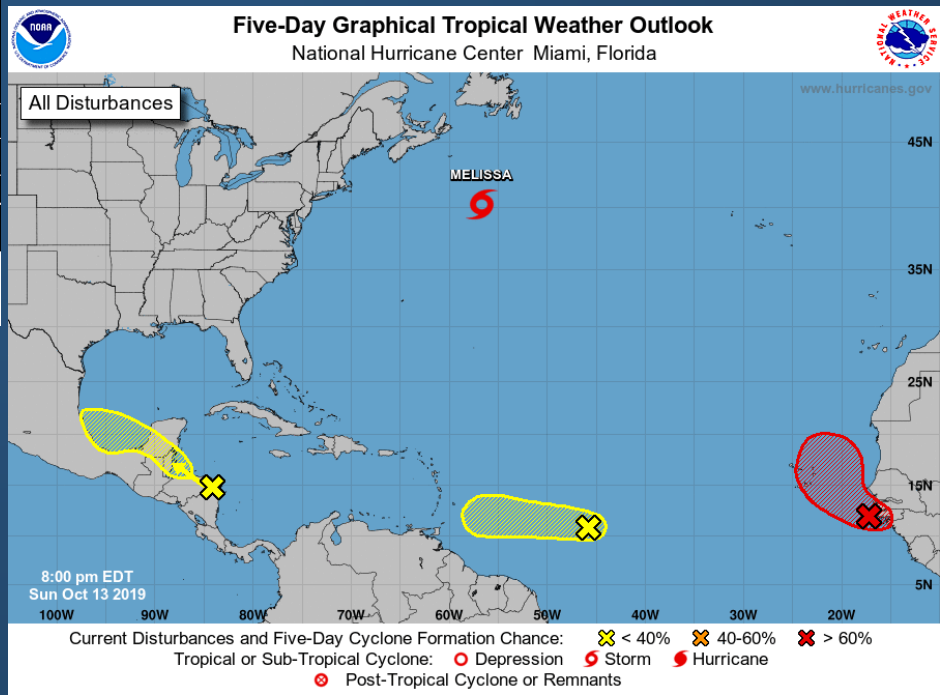
https://www.nhc.noaa.gov/gtwo.php?basin=atlc&fdays=2

- Shows current storms and areas of possible tropical/sub-tropical cyclone formation



2-day Outlook

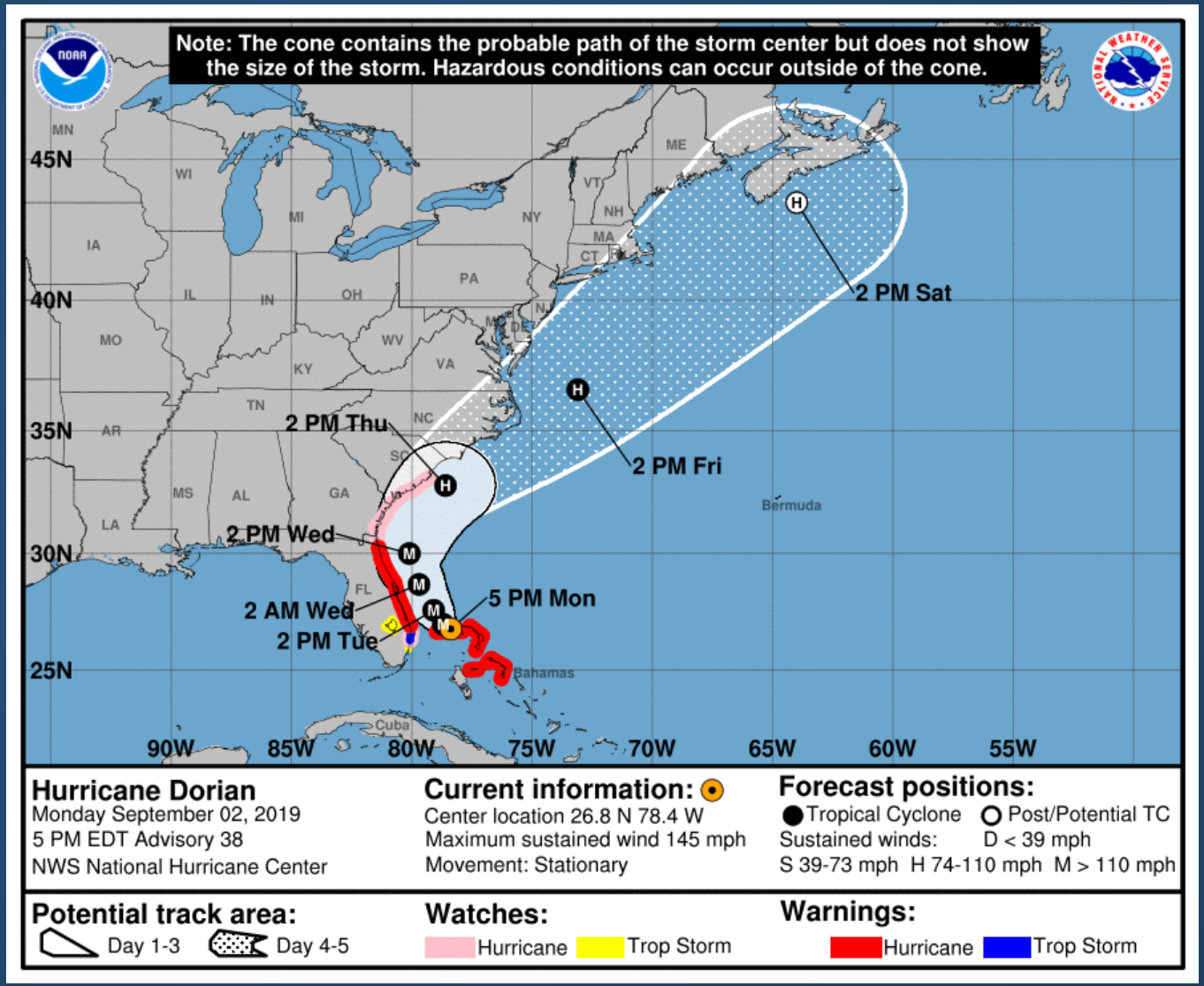
5-day Outlook



NHC Track Forecast Cone

- https://www.nhc.noaa.gov/cyclones/
- https://www.youtube.com/watch?v=04QRN5gUeO8&feature=youtu.be

- Shows the likely storm track along with the latest tropical storm/hurricane watches and warnings
- Can toggle on current wind field
- The "cone" does NOT indicate the area of possible impact, just the likely track of the storm center!



NHC Wind Speed Probabilities

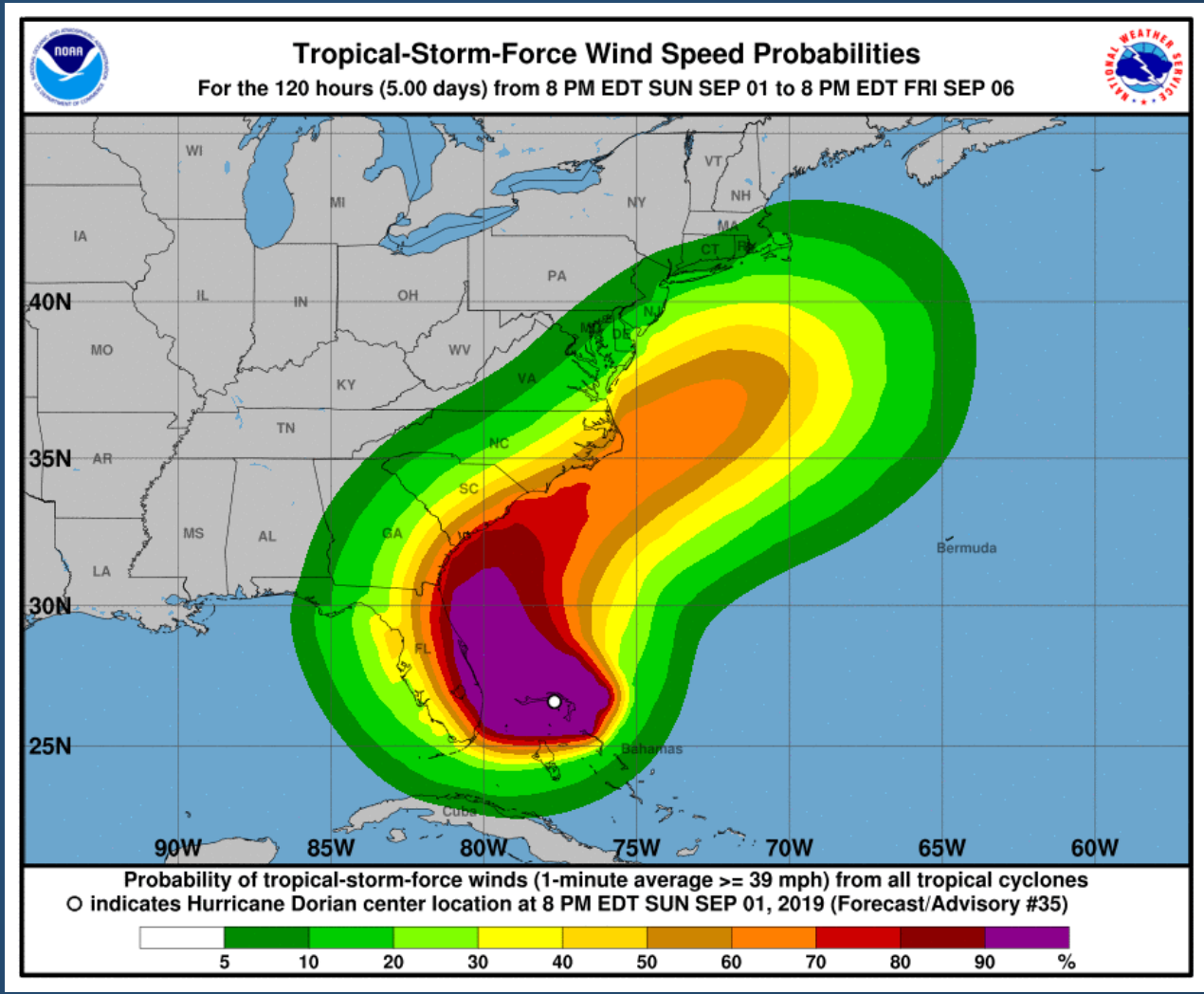
- https://www.nhc.noaa.gov/cyclones/

- Shows the chance of 34 knot (tropical storm force), 50 knot, and 64 knot (hurricane force) sustained winds through the next 5 days, as well as during particular time periods

- Accounts for uncertainty in the storm's track/size/intensity

- NOTE: Low probabilities do NOT necessarily imply low risk!

- Product description:
  - https://www.nhc.noaa.gov/aboutnhcgraphics.shtml?#WINDPROB



- The graphic above shows the probabilities of tropical storm force winds during the next 5 days

NHC Wind Speed Probabilities Example

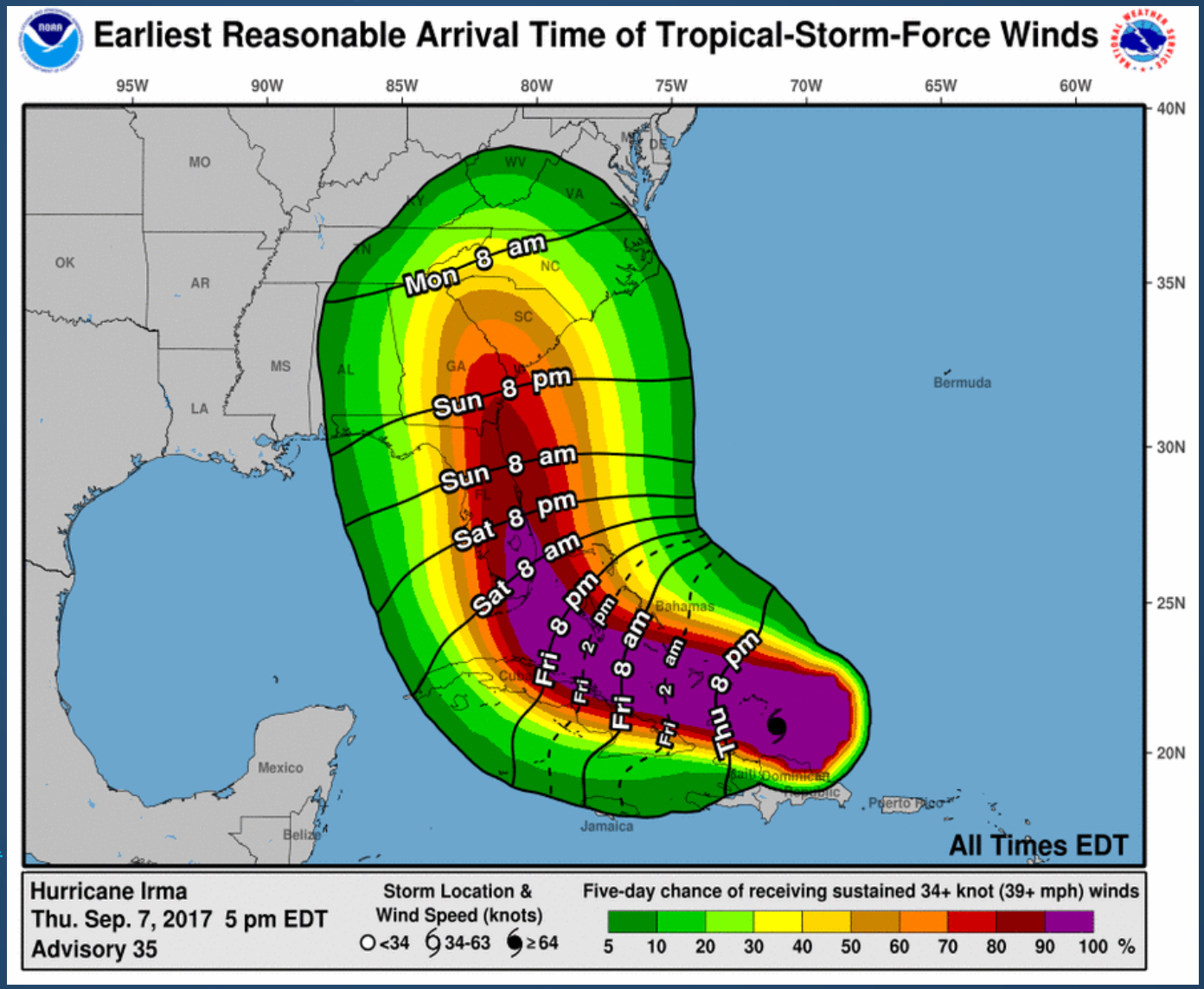
- https://www.nhc.noaa.gov/aboutnhcprod.shtml?#PWS

Forecast Hour		12	24	36	48	72	96	120
CHARLOTTE NC	34	X	X(X)	X(X)	X(X)	1(1)	3(4)	3(7)
MOREHEAD CITY	34	X	X(X)	4(4)	6(10)	13(23)	4(27)	2(29)
MOREHEAD CITY	50	X	X(X)	X(X)	X(X)	4(4)	2(6)	X(6)
MOREHEAD CITY	64	X	X(X)	X(X)	X(X)	1(1)	1(2)	X(2)
WILMINGTON NC	34	X	X(X)	4(4)	4(8)	6(14)	4(18)	1(19)
WILMINGTON NC	50	X	X(X)	X(X)	X(X)	1(1)	1(2)	1(3)
WILMINGTON NC	64	X	X(X)	X(X)	X(X)	X(X)	1(1)	X(1)
COLUMBIA SC	34	X	X(X)	1(1)	X(1)	X(1)	2(3)	2(5)
MYRTLE BEACH	34	X	1(1)	3(4)	2(6)	4(10)	2(12)	1(13)
CHARLESTON SC	34	X	2(2)	3(5)	X(5)	1(6)	1(7)	1(8)
SAVANNAH GA	34	X	2(2)	2(4)	X(4)	X(4)	X(4)	1(5)

- The probability for tropical storm force winds (34 kt) at Savannah, Georgia in the 24-36 hour time period is 4%, the cumulative probability through 48 hours is 8% and the cumulative probability for the entire 5-day period (120 hours) is 19%.

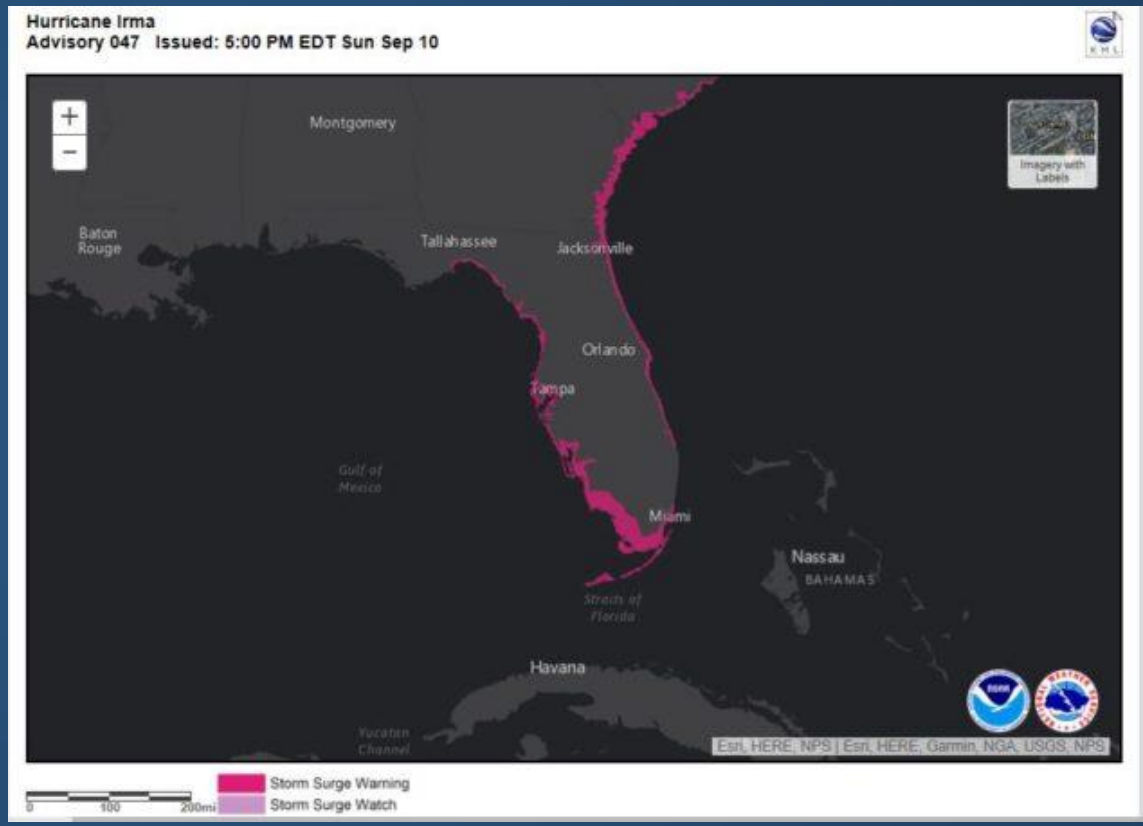
NHC Wind Time of Arrival Graphics

- "Earliest reasonable" arrival time of sustained TS-force winds (shown to the right; represents the time that has no more than a 10% chance of seeing the onset of sustained TS-force winds)
- "Most Likely" arrival time of sustained tropical storm-force winds (not shown; represents the time before or after which the onset of TS-force winds is equally likely)
- Product description:
  - https://www.nhc.noaa.gov/experimental/arrivaltimes/



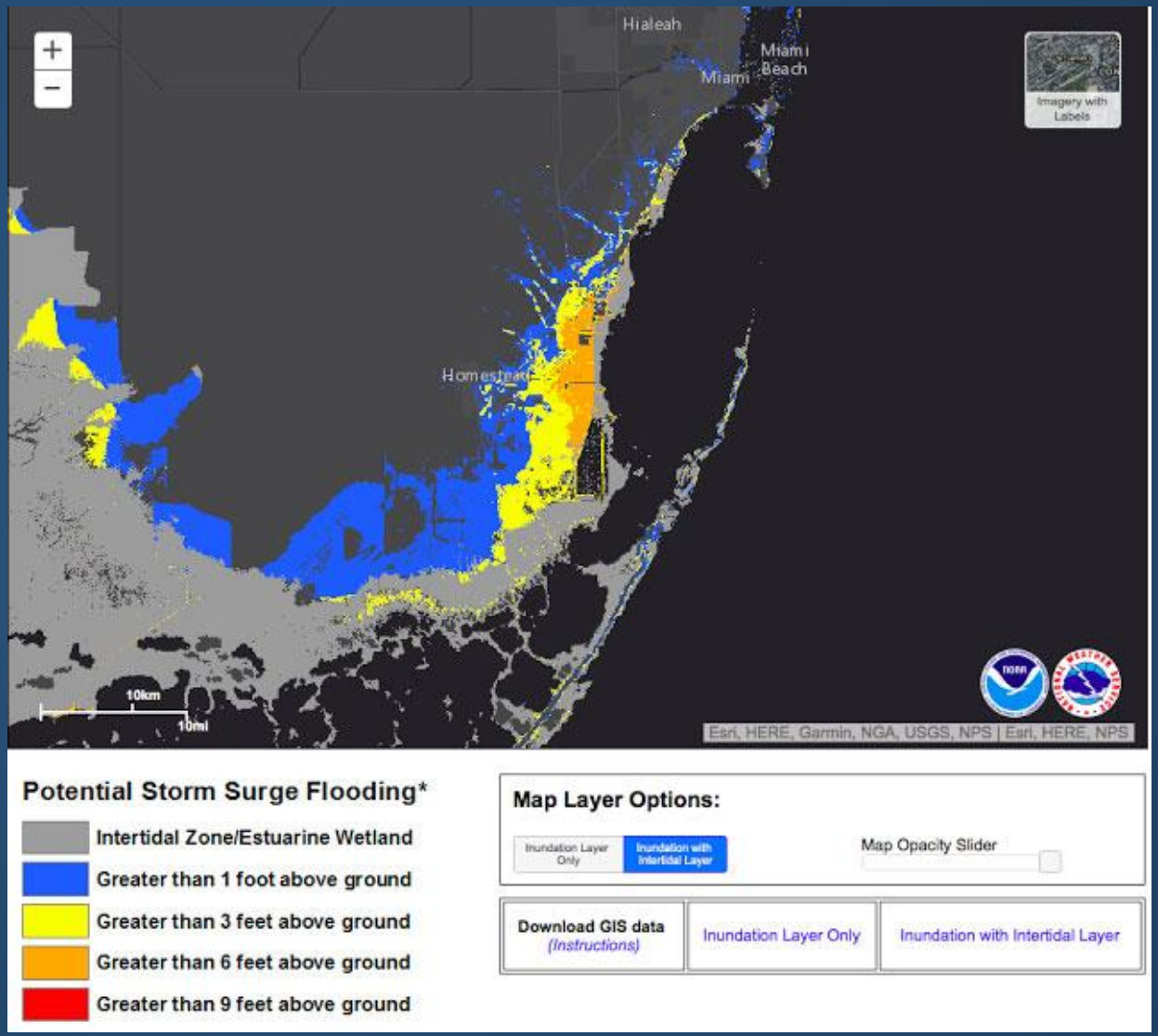
NHC Storm Surge Watch/Warning

- Highlights areas that have a significant risk of life-threatening storm surge inundation from a hurricane (or tropical storm)
  - Watch: conditions possible somewhere in the watch area within ~48 hours
  - Warning: conditions expected somewhere in the warned area within ~36 hours
- Subjectively determined based on collaboration between the NHC and local WFOs
- Available on the NHC's website shortly after each Advisory is issued
- Product description:
  - https://www.nhc.noaa.gov/aboutnhcgraphics.shtml?#WSURGE



NHC Potential Storm Surge Flooding Map

- Shows <u>potential</u> inundation (i.e., water heights above ground) that could result from a storm's surge combined with the astronomical tide (i.e., storm tide)
- Available on the NHC's website ~60-90 minutes after the 1st Hurricane Watch is issued for a storm (sometimes with a Tropical Storm Watch) and updated with each subsequent advisory
- **<u>ALWAYS</u> represents a reasonable worst-case scenario that people should prepare for**
  - *Thus, best used in the earlier stages of a storm*
- Product description:
  - https://www.nhc.noaa.gov/aboutnhcgraphics.shtml?#INUNDATION



NWS Wilmington Products

Hurricane Local Statement (HLS)

Hurricane Florence Local Statement Intermediate Advisory Number 54A
National Weather Service Wilmington NC AL062018
836 PM EDT Wed Sep 12 2018

This product covers southeast North Carolina and northeast South Carolina

Major Hurricane Florence continues to head toward the Carolina Coast

NEW INFORMATION
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* CHANGES TO WATCHES AND WARNINGS:
  - None

* CURRENT WATCHES AND WARNINGS:
  - A Tropical Storm Warning and Hurricane Watch are in effect for Bladen, Columbus, and Robeson
  - A Tropical Storm Watch is in effect for Darlington, Dillon, Florence, Marion, Marlboro, and Williamsburg
  - A Storm Surge Warning and Hurricane Warning are in effect for Central Horry, Coastal Brunswick, Coastal Georgetown, Coastal Horry, Coastal New Hanover, Coastal Pender, Inland Brunswick, Inland Georgetown, and Inland New Hanover
  - A Hurricane Warning is in effect for Inland Pender and Northern Horry

* STORM INFORMATION:
  - About 330 miles southeast of Wilmington NC or about 360 miles east-southeast of Myrtle Beach SC
  - 31.5N 73.2W
  - Storm Intensity 115 mph
  - Movement Northwest or 315 degrees at 16 mph

SITUATION OVERVIEW

Major Hurricane Florence continues to approach the Carolina Coast. Florence will bring life-threatening storm surge inundation, catastrophic flooding rainfall, including prolonged significant river flooding, and extreme winds to the region on Thursday. Cataclysmic conditions are expected to continue Friday through Sunday as the hurricane slowly crosses Cape Fear and moves into South Carolina.

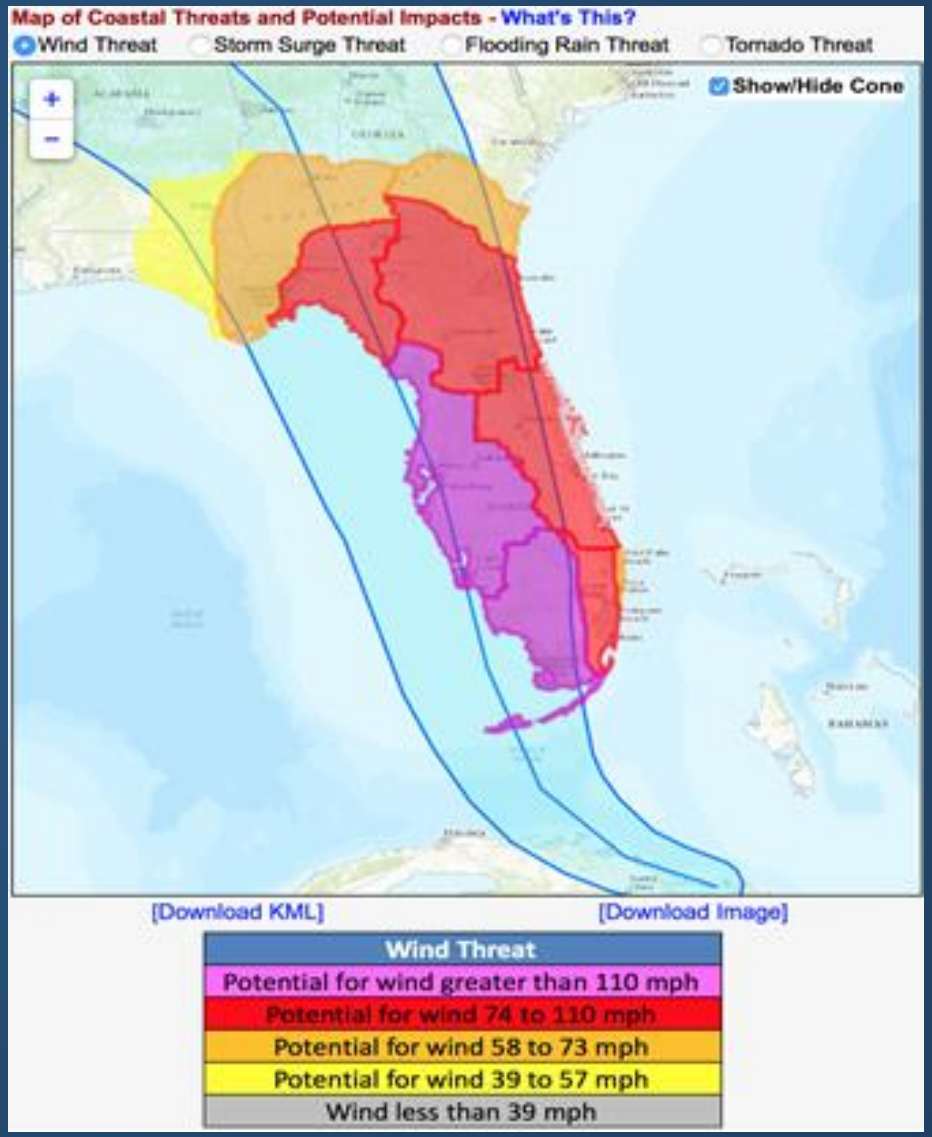
- "Big Picture" overview of the storm, including the potential impacts across southeast NC/northeast SC

« Portion of a HLS issued for Hurricane Florence (2018)

NWS Wilmington Products

Hurricane Threats and Impacts Graphics

- Shows the threat levels and potential impacts from wind, storm surge, rainfall and tornadoes that people should prepare for
- Provides recommended protective actions
- Product description:
  - https://www.weather.gov/media/srh/tropical/PDD_HTI.pdf



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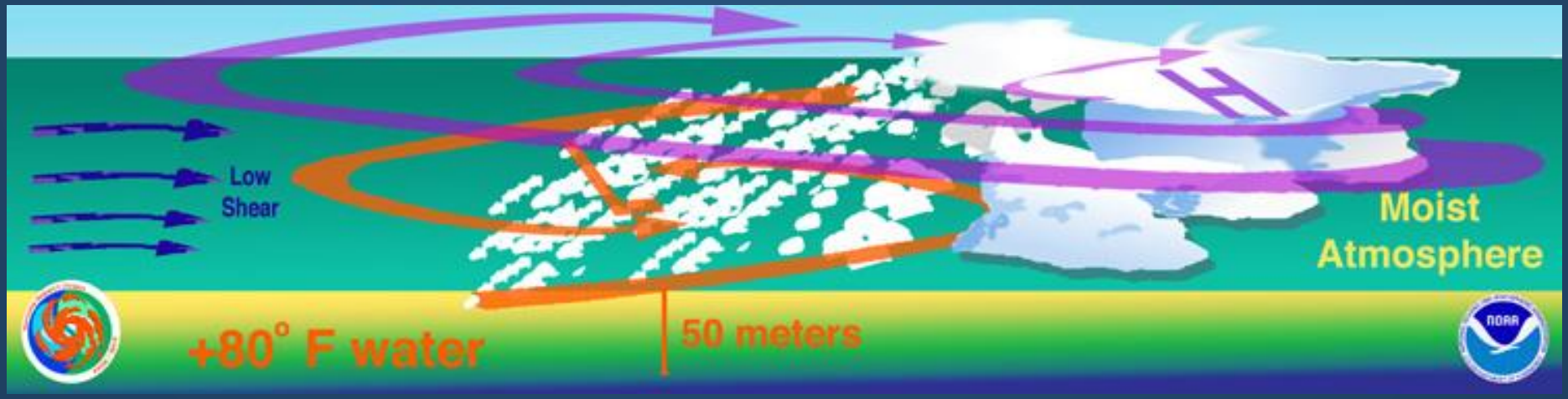
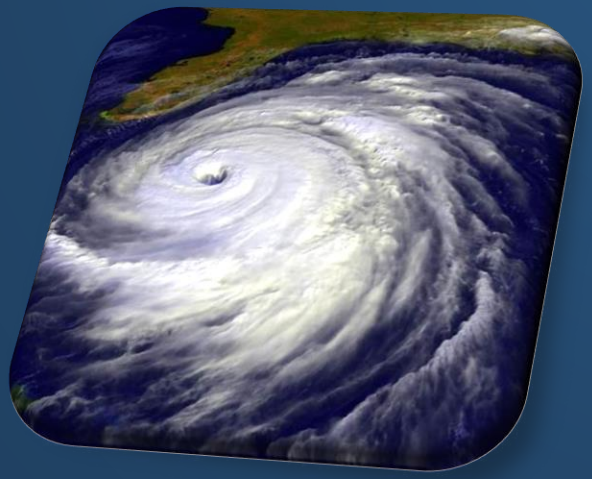
Tropical Cyclone Basics

- Tropical Cyclone: rotating system of showers and thunderstorms originating over tropical or subtropical waters and having a closed low-level circulation (i.e., at least one isobar around the center)
- Ingredients needed for development:
  - Ocean water temperatures 80 degrees Fahrenheit or greater
  - Low amounts of vertical wind shear (i.e., winds of different strengths/directions at different heights)
  - Moist and unstable air (i.e., air prone to rising)
  - Pre-existing near-surface low pressure with sufficient spin



Tropical Cyclone Stages

- Tropical Disturbance
- Tropical Depression
- Tropical Storm
- Hurricane



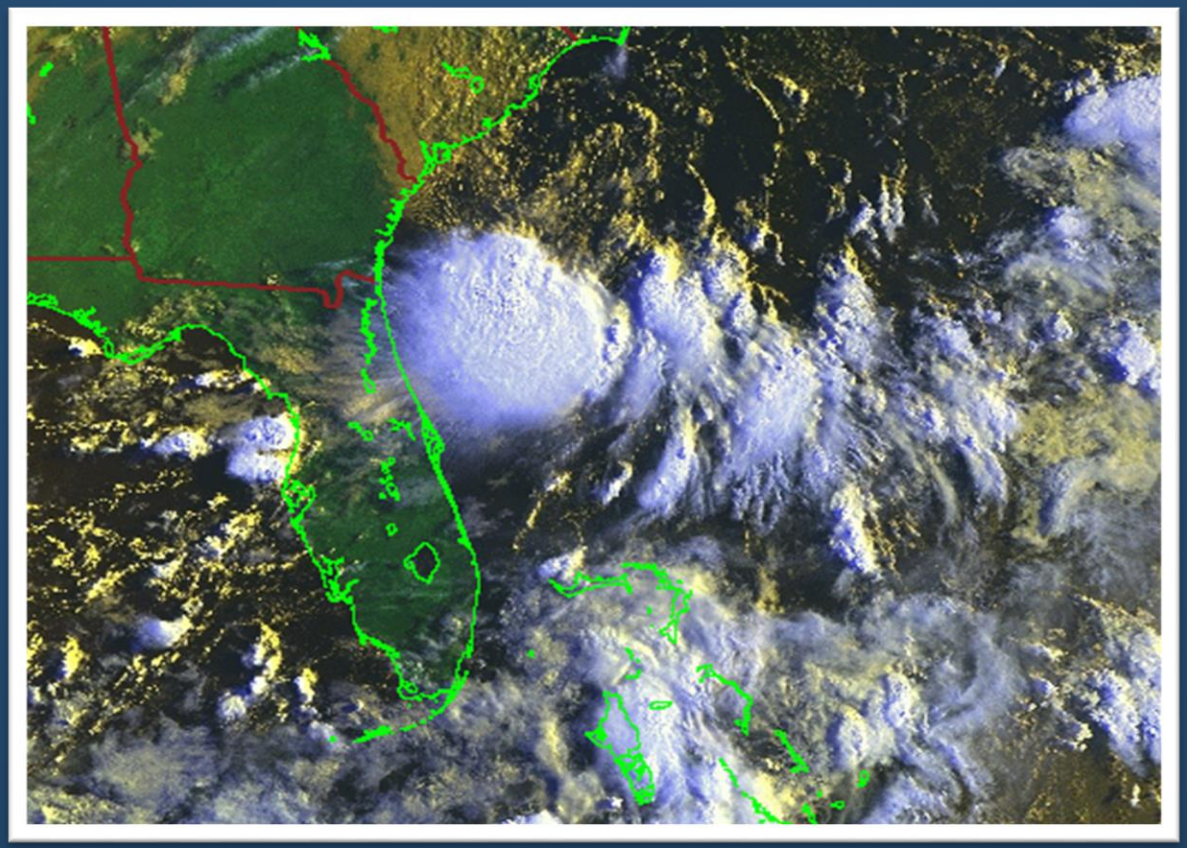
- Potential tropical cyclone: disturbance which has a high chance of becoming a tropical cyclone

- Post-tropical cyclone: former tropical cyclone which no longer possesses sufficient tropical characteristics but can still produce strong winds and heavy rain

Tropical Cyclone Stages

Tropical Disturbance

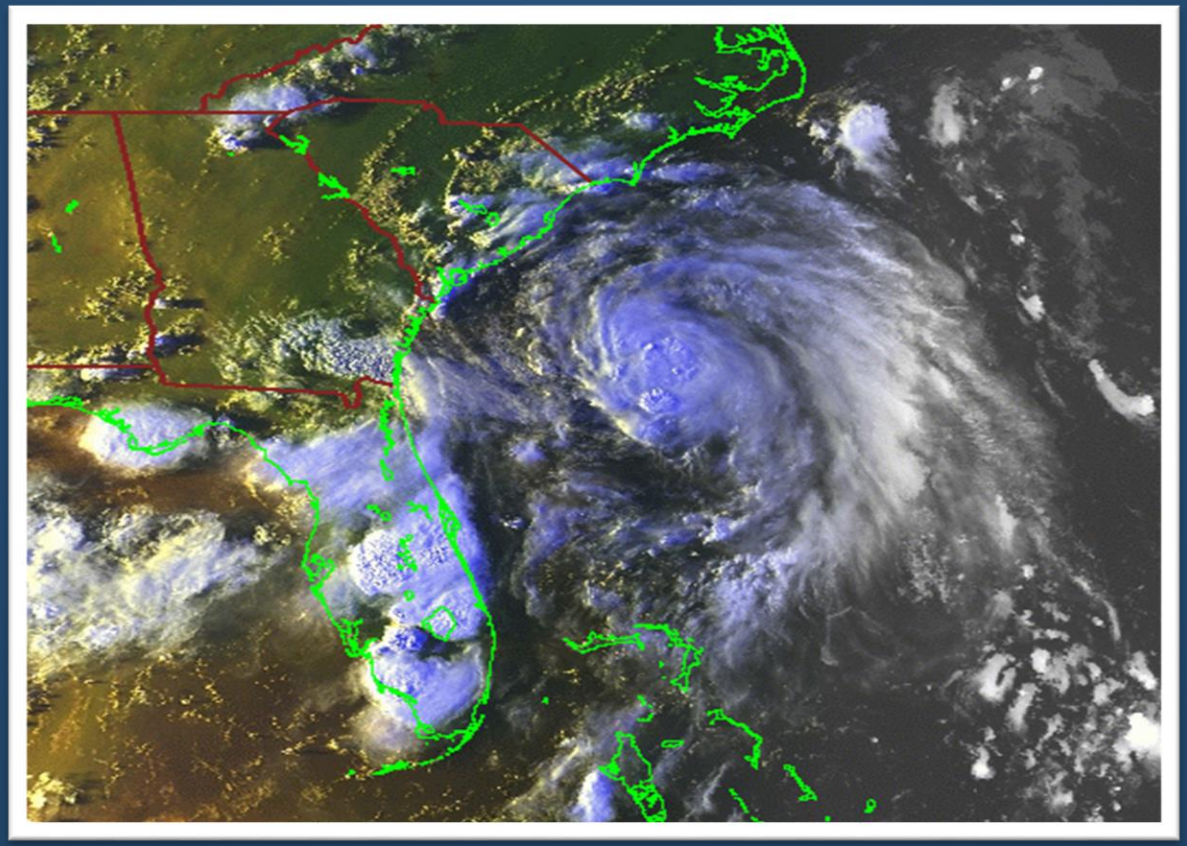
- no organized surface circulation
- disorganized cluster of thunderstorms



Tropical Cyclone Stages

Tropical Depression

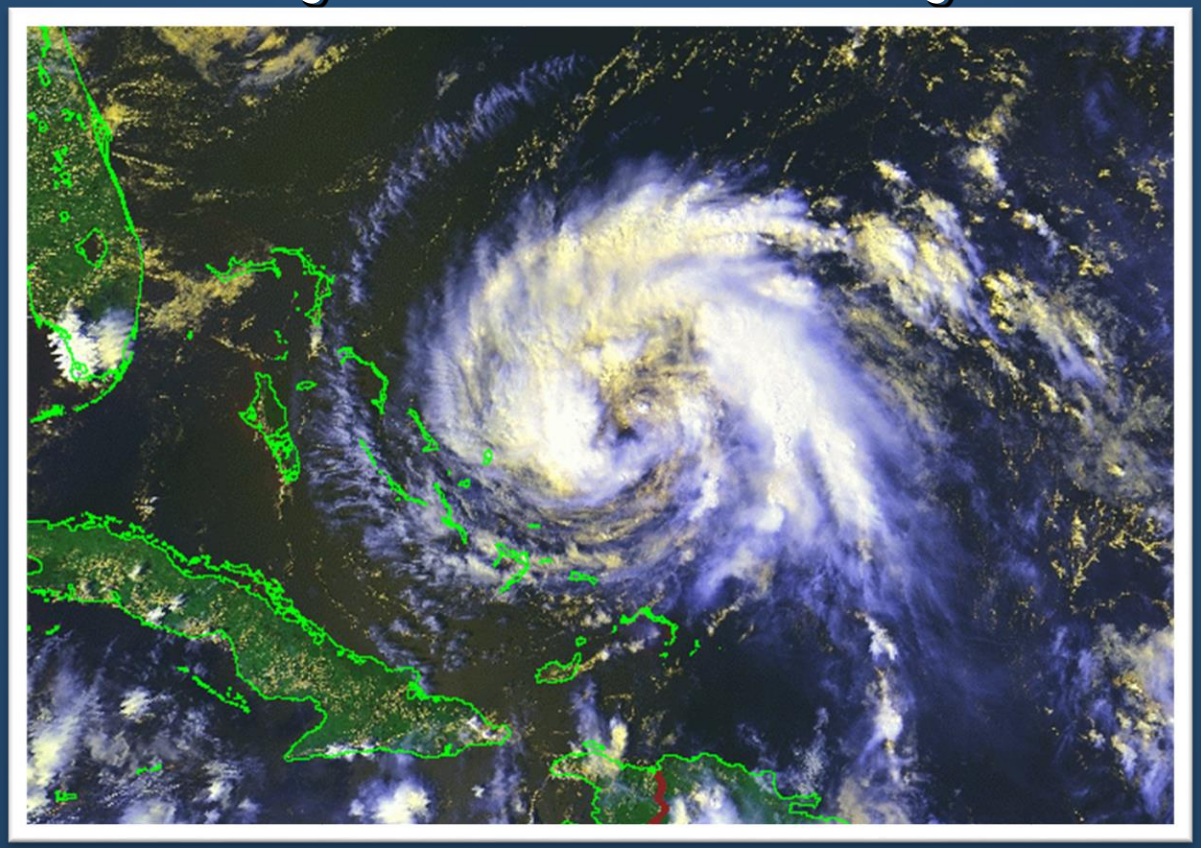
- sustained winds less than 39 mph
- surface low pressure better organized



Tropical Cyclone Stages

Tropical Storm

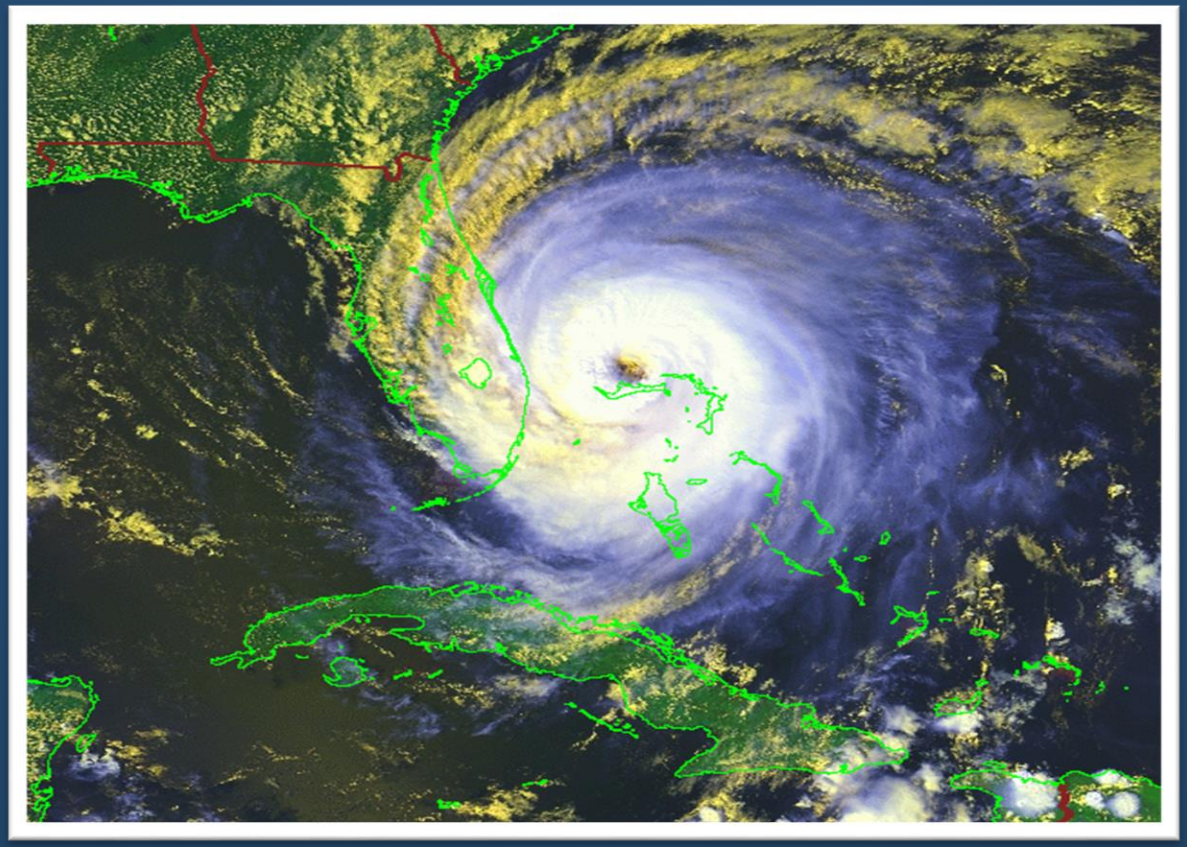
- sustained winds of 39-73 mph
- more organization of thunderstorms around the center
- gets a name at this stage



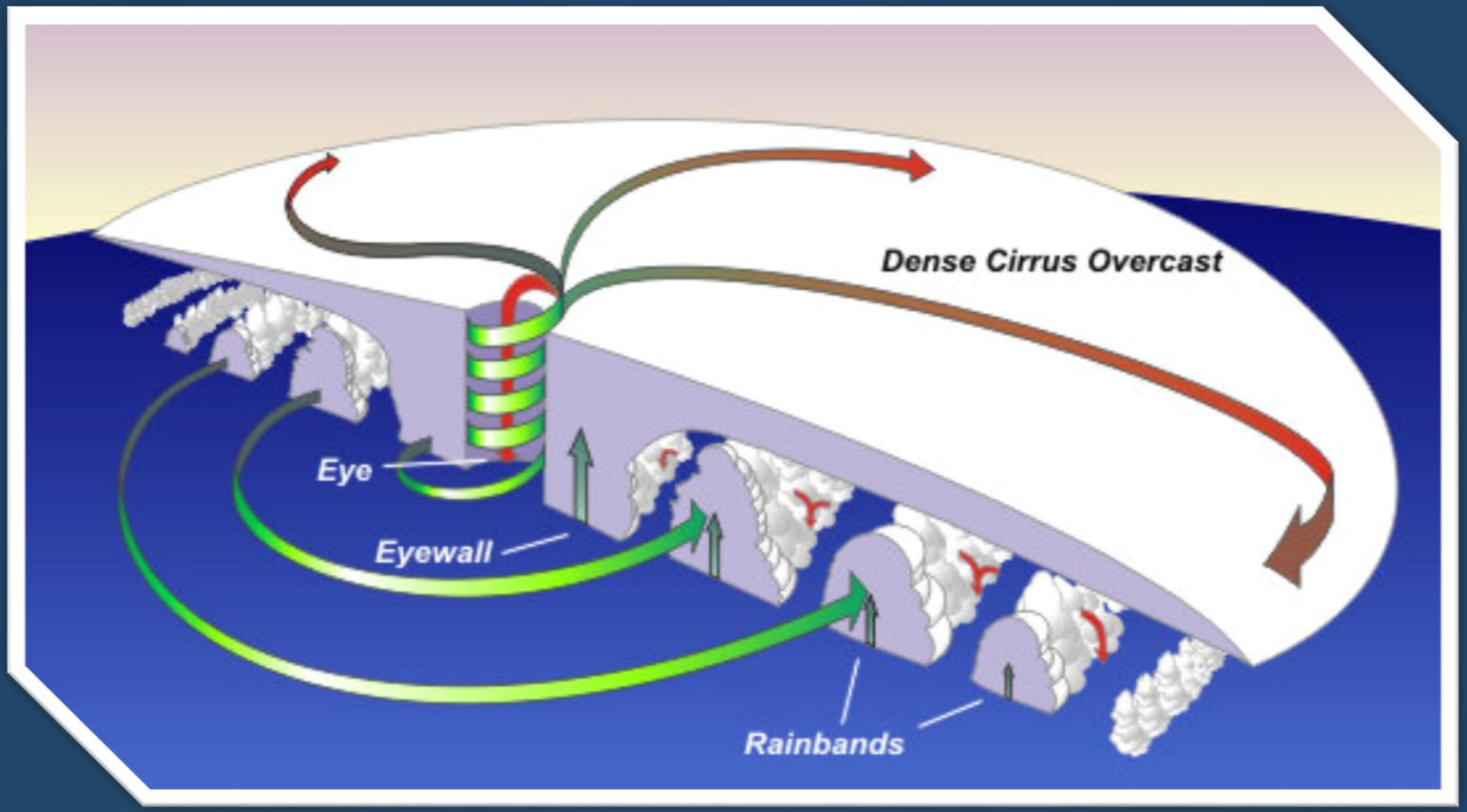
Tropical Cyclone Stages

Hurricane

- sustained winds of 74 mph or greater
- very well-organized system with thunderstorms around the central "eye" as well as in rain bands spiraling inward toward the center



Hurricane Structure



- The eye wall surrounds the calm eye and typically contains the strongest winds
- The outer rain bands contain gusty winds, heavy rain and some tornadoes

Saffir-Simpson Hurricane Wind Scale

- https://www.nhc.noaa.gov/aboutsshws.php

- Category 1:
  - 74-95 mph winds
  - minimal damage
- Category 2:
  - 96-110 mph winds
  - moderate damage
- Category 3:
  - 111-129 mph winds
  - major damage
- Category 4:
  - 130-156 mph winds
  - extreme damage
- Category 5:
  - 157+ mph winds
  - catastrophic damage

Major hurricanes (Cat 3-5) produce 85% of all hurricane damage!

NOTE: This scale should NOT be used to determine the amount of storm surge a hurricane can produce!!

Hurricane Observing & Forecasting

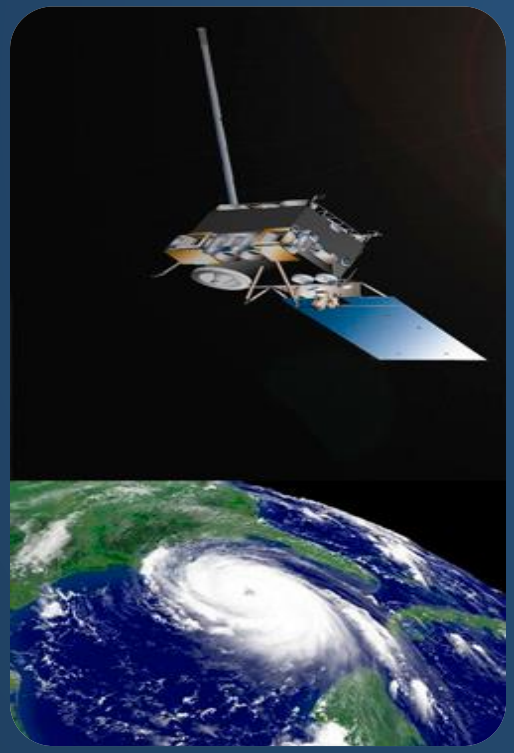
Aircraft – "Hurricane Hunters"

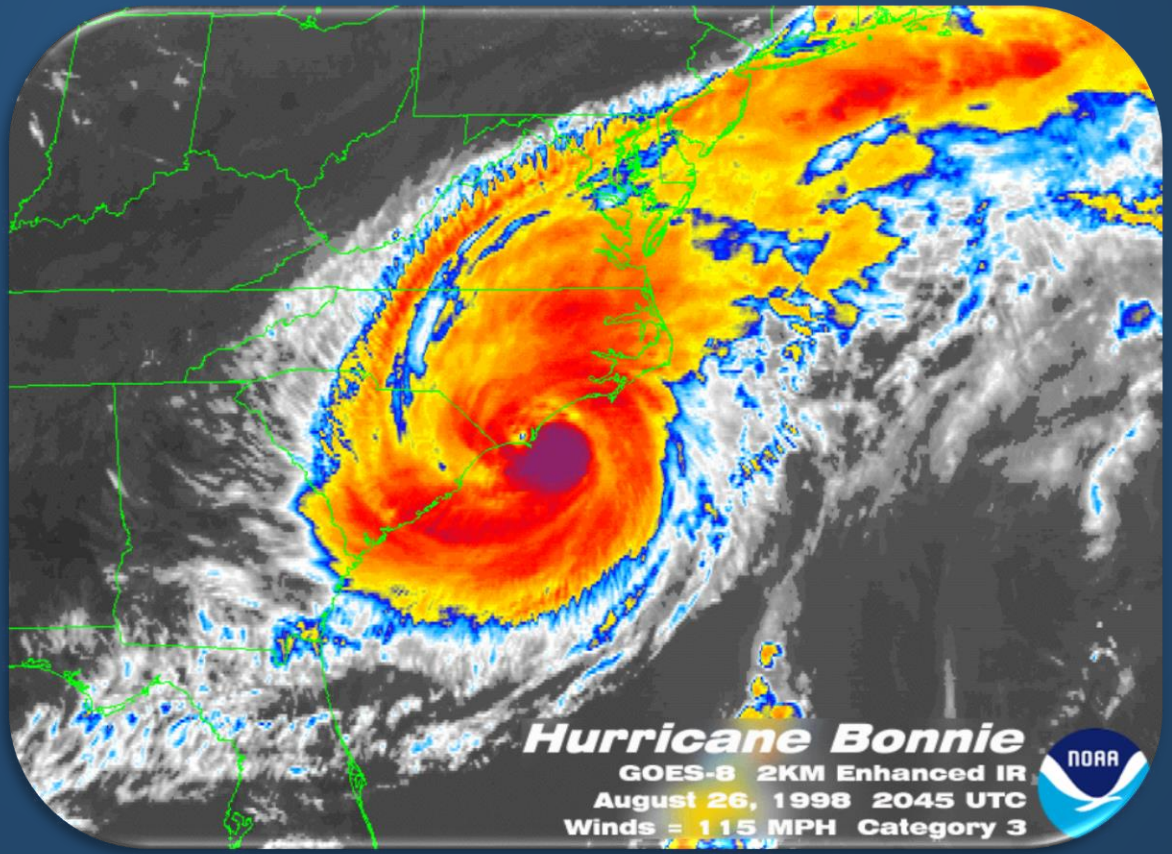
- NOAA P-3/Air Force Reserve WC-130
  - samples storm environment between 500 – 10,000 feet
- NOAA Gulf Stream IV
  - samples a large area around storm ~45,000 feet high

Hurricane Observing & Forecasting

Satellites

- Global Network of Geostationary and Polar Orbiters
  - used for hurricane analysis, tracking and forecasting

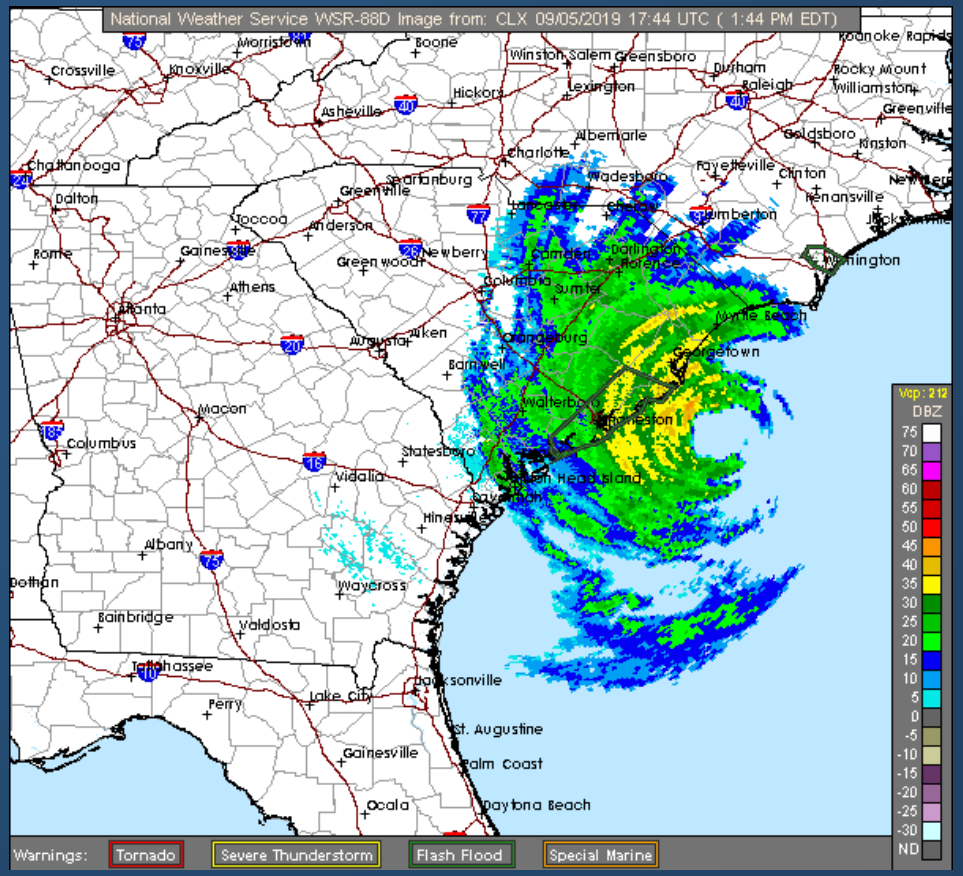




Hurricane Observing & Forecasting

NWS Doppler Radar

- observe rain, wind and possibly tornadoes
- help determine the center of the storm (which is important for track forecasting)



Hurricane Observing & Forecasting

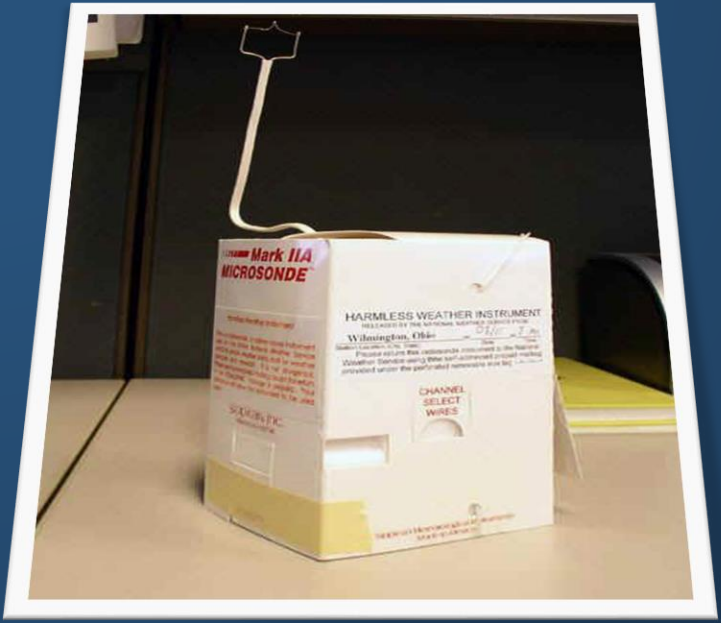
Buoys, Ships, & Land-based Observations

- observe atmospheric and oceanic conditions

Hurricane Observing & Forecasting

Weather Balloons/Radiosondes

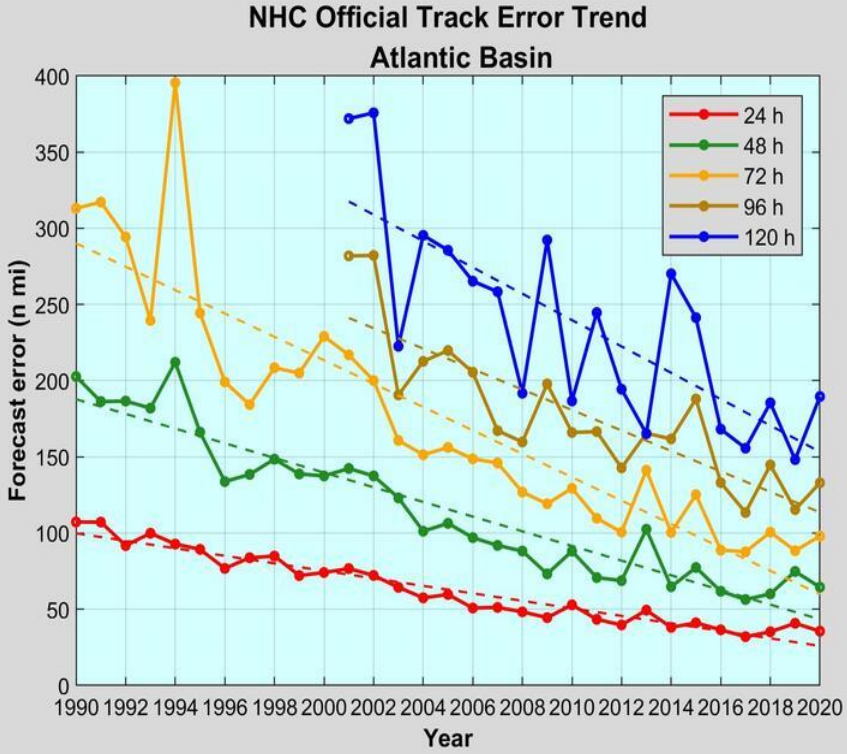
- launched up to 4 times per day during hurricanes
  - Only by some NWS offices (not including Wilmington, NC)
- observe atmospheric pressure, temperature, wind and humidity up to ~20 miles high
- help initialize weather forecast models

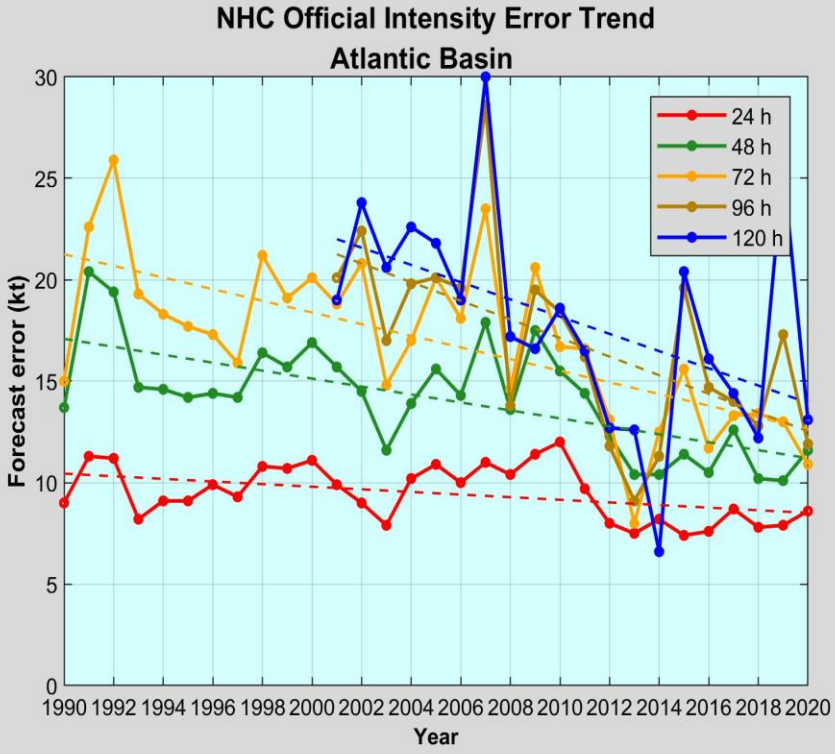


Hurricane Observing & Forecasting

Forecast Models

- There are many different types of models utilized by the National Hurricane Center to make their storm track/intensity forecasts
- As shown below, the NHC's official track/intensity forecasts have been improving over the last several decades (especially track forecasts)





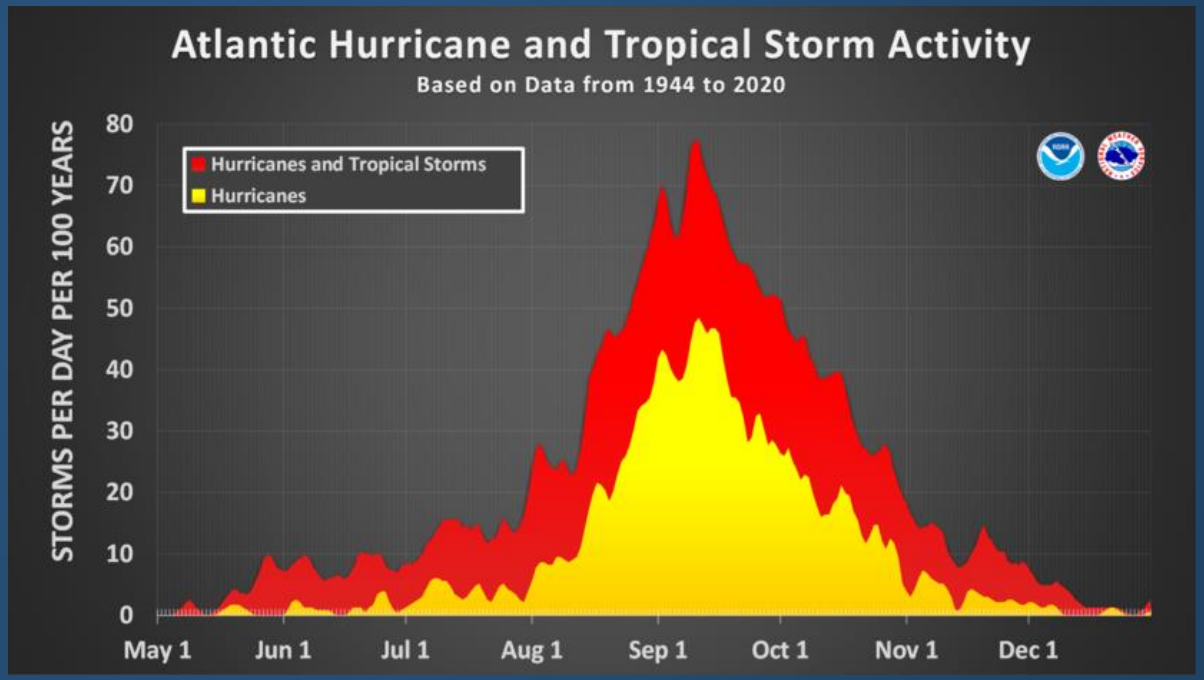
Outline

- Tropical Cyclone Hazards
- Being Prepared and Staying Informed
- Tropical Cyclone Basics
- **Tropical Cyclone Climatology**
- Tropical Cyclone History for Southeast North Carolina and Northeast South Carolina

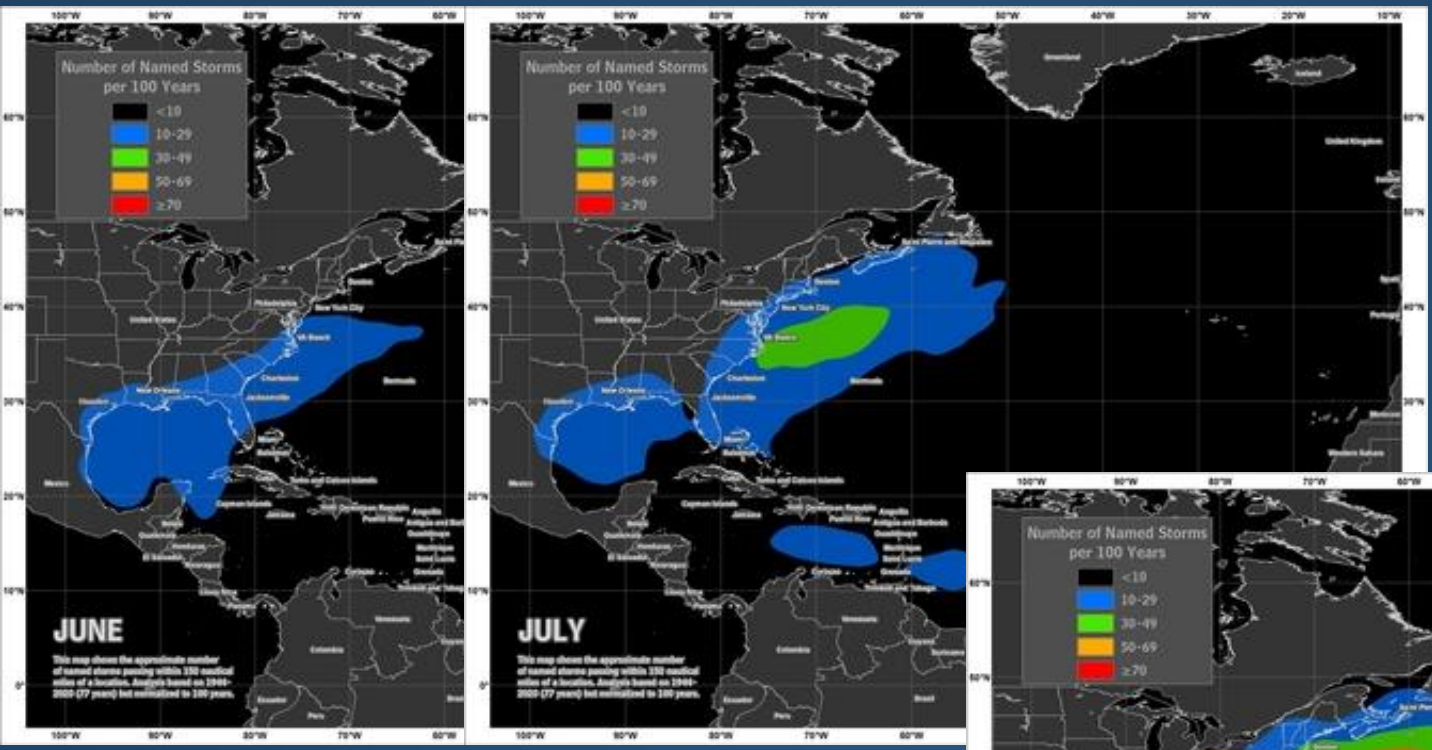
Atlantic Basin Hurricane Season

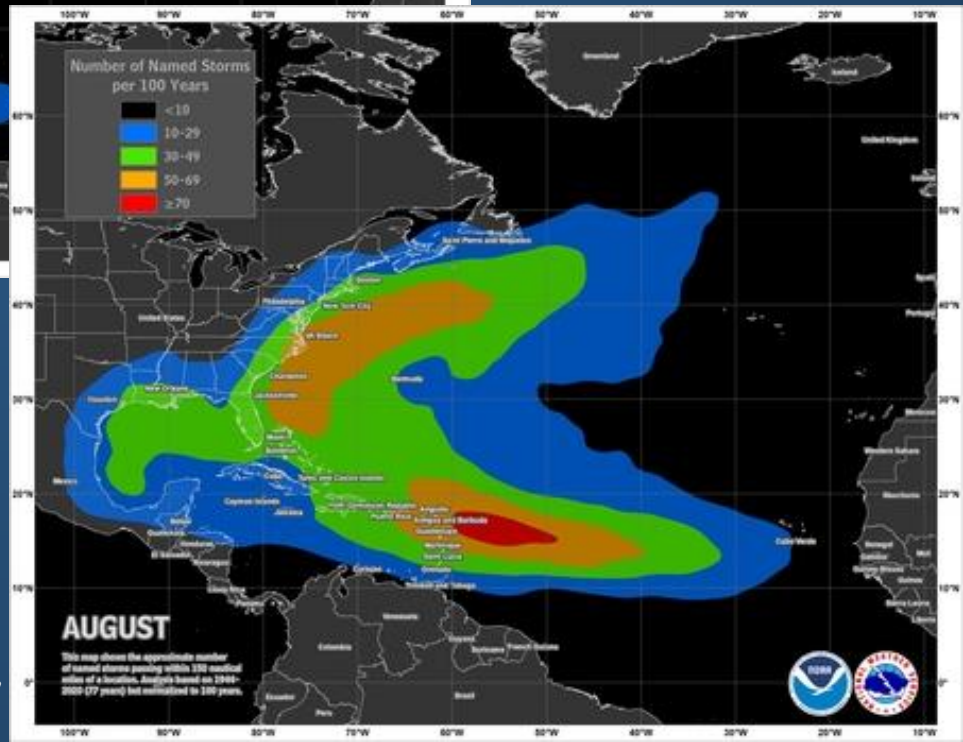
June 1 – November 30

- Includes most of northwest Atlantic Ocean, the Caribbean Sea and the Gulf of Mexico
- Peak of the season is ~ September 10
- However, tropical cyclones can occur before June and after November
- More info: hurricanes.gov/climo



Tropical Cyclone Formation Areas By Month

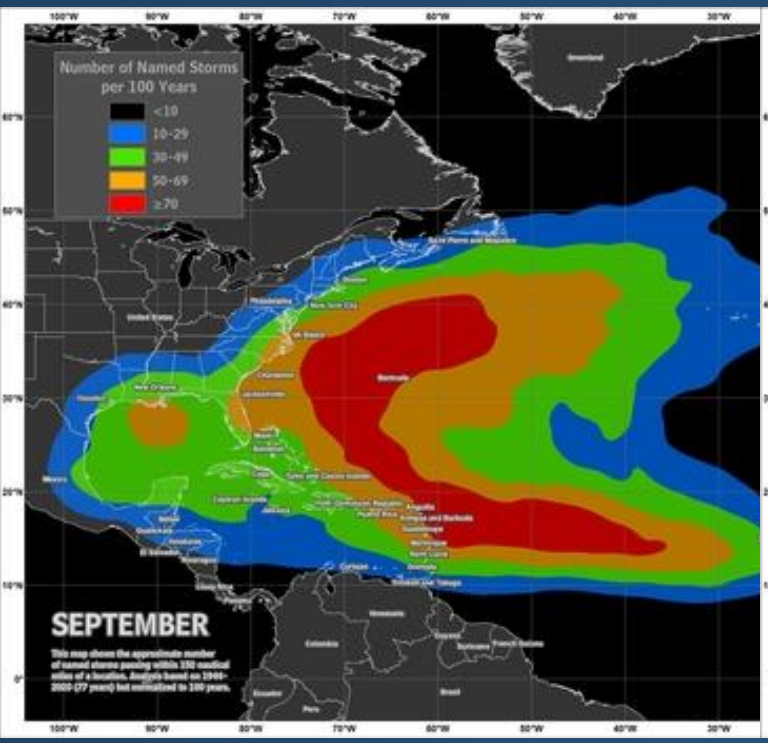


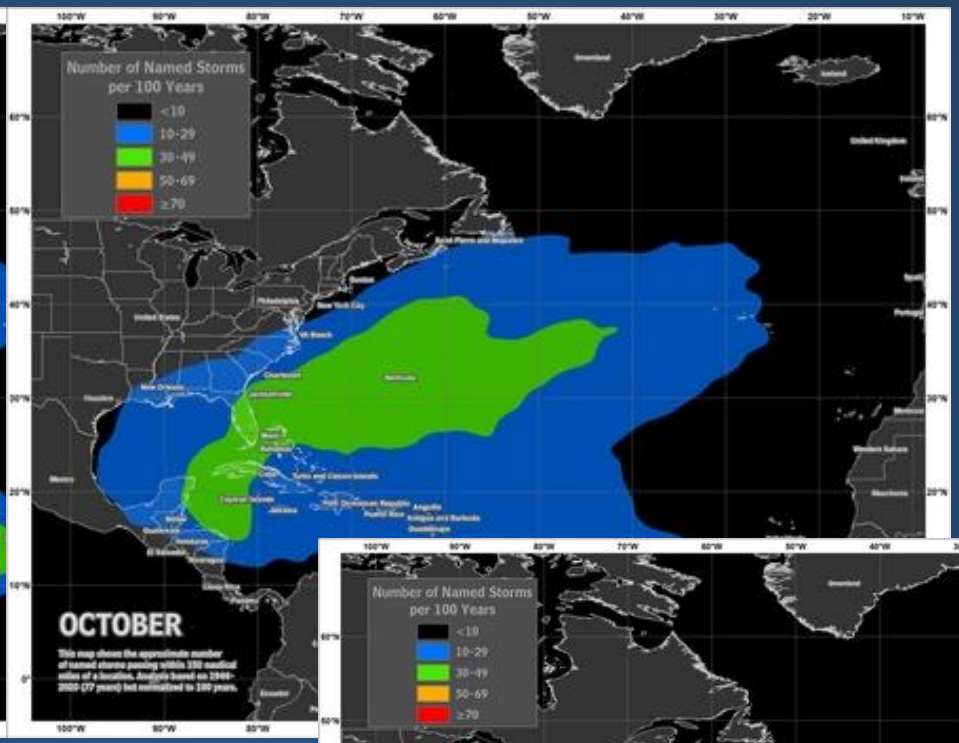


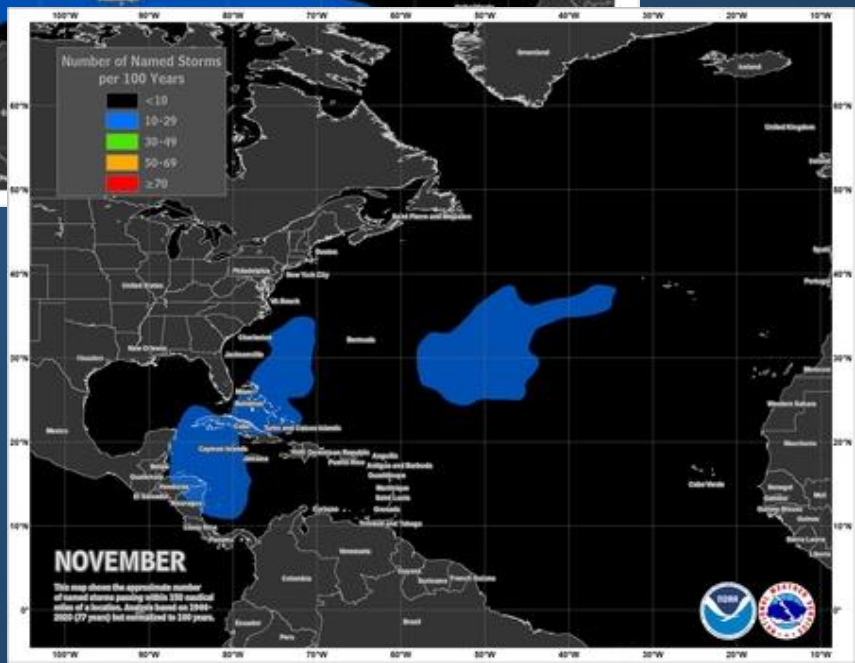
- More info: hurricanes.gov/climo/#ori

» *Images courtesy of NWS/NHC*

Tropical Cyclone Formation Areas By Month



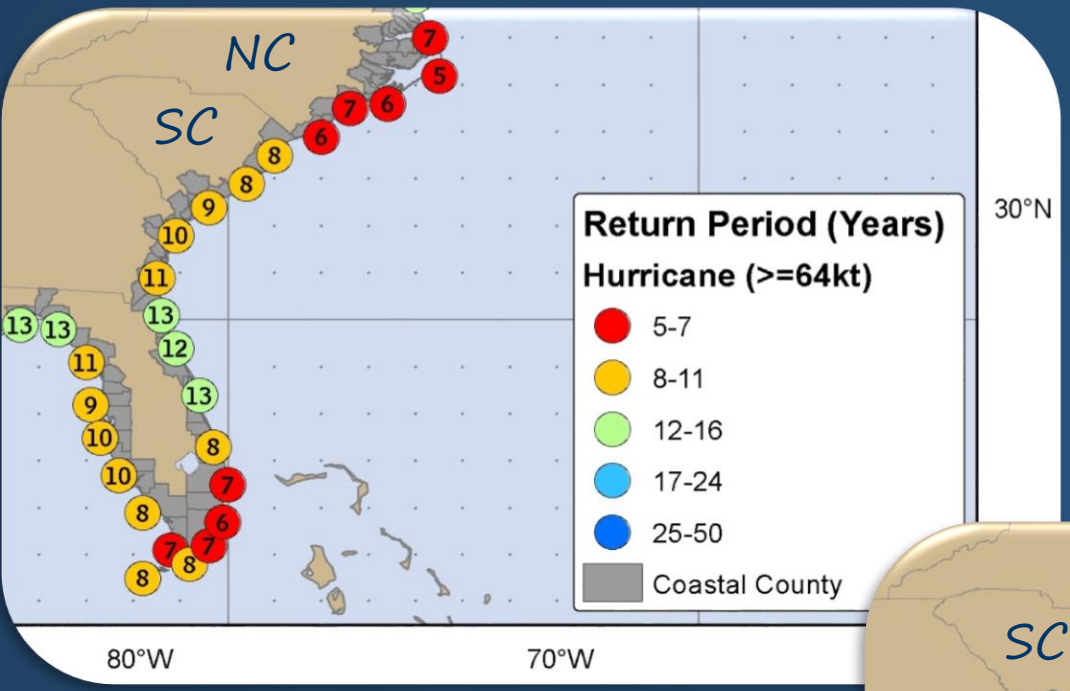




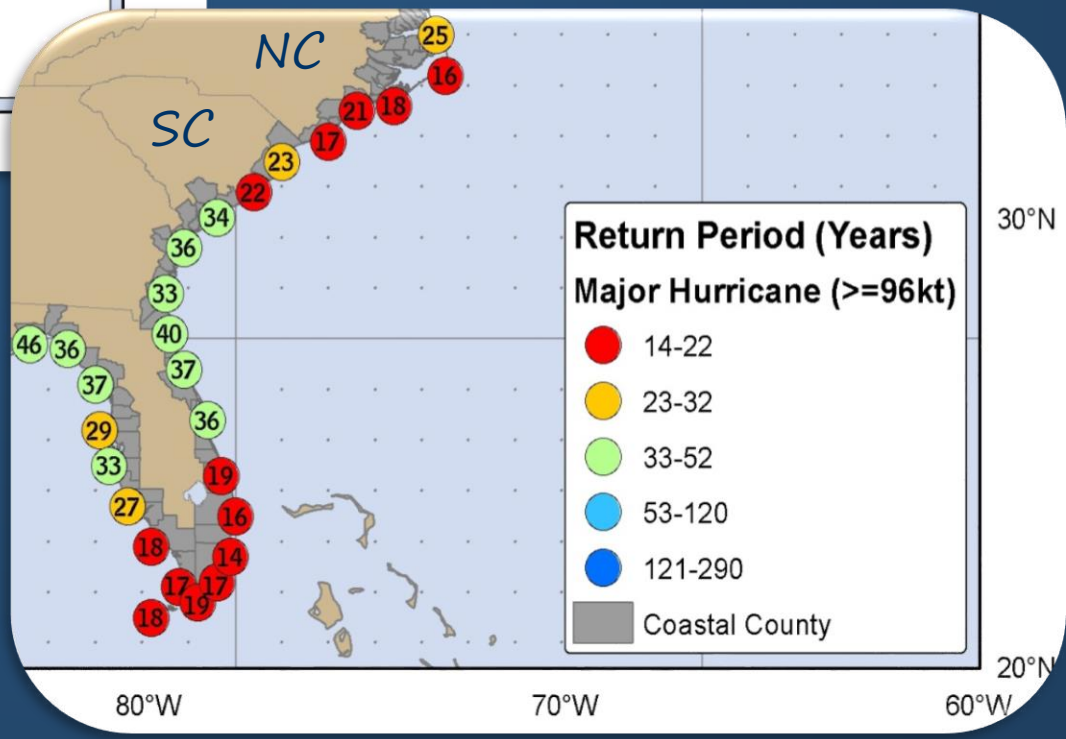
- More info: hurricanes.gov/climo/#ori

  - *Images courtesy of NWS/NHC*

Hurricane Return Periods



- **Return Period**: frequency of a particular event



- <u>On average</u>, a hurricane passes within 58 miles of Wilmington (Myrtle Beach) every 6 (8) years with a major hurricane doing so every 17 (23) years

- More info: hurricanes.gov/climo/#returns

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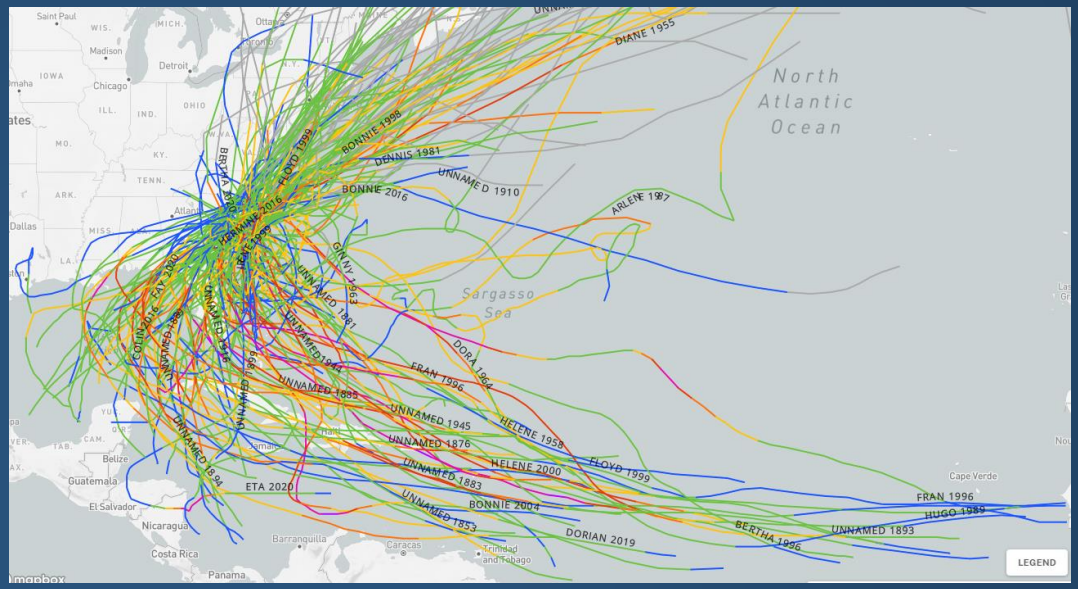
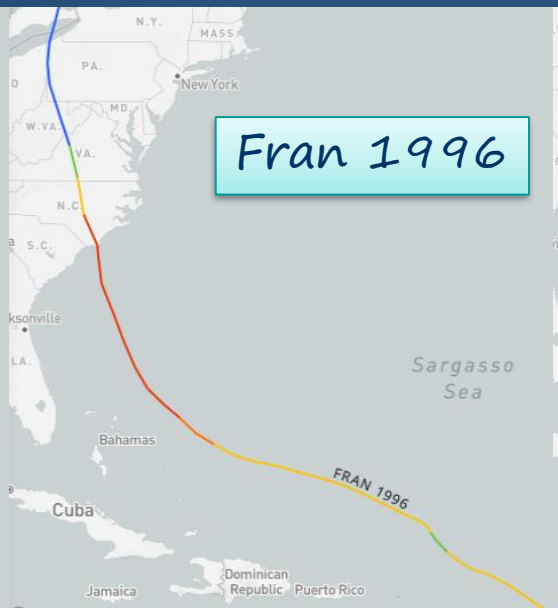
Local Tropical Cyclone History

https://www.weather.gov/ilm/SignificantLocalEvents

- From 1851 (when official records begin) through 2021, 156 tropical cyclones (tropical depressions, tropical storms and hurricanes) tracked within 100 miles of North Myrtle Beach, SC



» *Images courtesy of NOAA*



Important Links

- **Tropical Cyclone Safety/Preparedness**
  - NWS:
    - weather.gov/safety/hurricane
  - NOAA:
    - weather.gov/hurricane
  - Federal Emergency Management Agency (FEMA):
    - fema.gov
  - Department of Homeland Security:
    - ready.gov/hurricanes
  - South Carolina Emergency Management Agency (includes evacuation zone/route info):
    - scemd.org
  - North Carolina Emergency Management Agency (includes evacuation zone/route info):
    - ncdps.gov/our-organization/emergency-management
    - readync.gov
- **Tropical Cyclone Forecasts**
  - NHC: hurricanes.gov
  - NWS Wilmington, NC: weather.gov/ilm/tropical

Important Links

- **Storm Surge**
  - NHC: hurricanes.gov/surge
  - Risk Maps: hurricanes.gov/nationalsurge
- **Southeast NC & Northeast SC Tropical Cyclone History**
  - weather.gov/ilm/SignificantLocalEvents
- **Tropical Cyclone Frequently Asked Questions (FAQ)**
  - aoml.noaa.gov/hrd-faq
- **NOAA Education**
  - noaa.gov/education/resource-collections/weather-atmosphere/hurricanes
- **Tropical Cyclone Names**
  - hurricanes.gov/aboutnames.shtml
- **Hurricane Tracking Charts**
  - hurricanes.gov/tracking_charts.shtml

We Wish You a Safe Hurricane Season!

weather.gov/ilm

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